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THE EPILEPTIC SEIZURE

ITS RELATION TO NORMAL THOUGHT AND NORMAL ACTION *

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HOPELESS AND HOPEFUL FACTORS OF THE PROBLEM OF EPILEPSY

The difficult problem of specific susceptibility is, in its application to epilepsy, complicated by the importance of ascertaining the particular cause of the predisposition in the particular person. That epilepsy is a symptom-complex incidental to an abnormal functioning of the brain is an opinion advanced some thousands of years ago by Hippocrates.[1] From this opinion few if any dissent today. The discovery, however, of a large number of abnormal conditions which, by their action on the brain, may give rise to the disorder, compels a point of view from which the truth of the general proposition is seen in a new light.

Every physician is impressed with the fact that of a number of persons who have been subject to the same disease or accident, only a few become afflicted with epilepsy. The observations of Wilson,[2] Hauptmann,[3] Wallon [4] and of others,[5] of the relation of war injuries to the causation of epilepsy, reveal the existence of predisposing factors in a large number of cases. The assumption that a disease or an accident is potent to produce the disorder only when acting on an abnormal brain is indeed upheld by the study of its hereditary features. The latter, however, may be variously interpreted. Gowers' [6] statistics, showing that a large proportion of epileptic patients are born of insane or epileptic antecedents, it is true, are upheld by the latest investigations.[7] But all

1. Adams: The Genuine Works of Hippocrates; The Sacred Disease, New York, William Wood & Company.

2. Wilson, S. A. K.: Rôle of Trauma in the Etiology of Organic and Functional Nervous Diseases, J. A. M. A. **81**:2172 (Dec. 29) 1923.

3. Hauptmann, A.: Ueber Epilepsie im Lichte der Kriegerfahrungen, Ztschr. f. d. ges. Neurol. u. Psychiat. **36**:181, 1917.

4. Wallon, H.: Lésions nerveuses et troubles psychiques de guerre, J. de psychol. **17**:67, 1920.

5. Holmes and Sargent, quoted by Wilson (footnote 2).

6. Gowers, William R.: Epilepsy and Other Chronic Convulsive Diseases, Philadelphia, P. Blakiston's Son and Company, 1901.

7. Burr, C. W.: Heredity in Epilepsy, Arch. Neurol. & Psychiat. **7**:721 (June) 1922.

such statistics fail on the main point. They do not afford any information regarding the particular defect in the parent which, when inherited by the child, makes the latter an epileptic. Thus, even when one finds that of two persons who have received an equally heavy blow on the head, the one who in consequence became afflicted with epilepsy or insanity was the child of an insane or an epileptic parent, one is still in ignorance as to whether the underlying cause of the disorder in both parent and child was due to some constitutional defect acting on a normal brain, or to an essentially abnormal brain.

Much light is shed on this difficult problem by certain discoveries. Their significance of the utmost gloom is mitigated by their value as a warning of impending danger to the human race. They deserve, therefore, the serious consideration of every thinking person.

One is the discovery of intra-ocular and subarachnoid hemorrhage in the new-born. Of 400 infants examined within twenty-four hours after birth, Sicherer [8] discovered intra-ocular hemorrhage in sixty-five—somewhat more than 16 per cent. Much larger percentages were found by other observers: thirty-two by Schleich and thirty-four by Paul.[9] Jacobs,[10] on the other hand, found it in only a little over 12 per cent. The rapid disappearance of the signs of intra-ocular hemorrhage makes for the discrepancy of the results found by different investigators. All investigators agree that these hemorrhages are due to an excessive pressure exerted on the head of the child during birth, and that "etiologically they stand in some relation to the minute and larger cerebral hemorrhages." Paul's [11] classification of the causes of such hemorrhage is interesting. It is as follows: "Narrow pelvis, 50 per cent; prematurity, 40 per cent; complicated and protracted labor, 40 per cent; normal labor, with child of normal size, 20 per cent." It thus appears that even normality of birth is but small guaranty against an abnormal outcome of the process. The seriousness of the problem may be estimated from the measures of relief advocated and adopted by those best qualified in that sphere. From the "easy and harmless" cranial puncture employed by Henschen, Frazer, Doazen and Green,[12] to a "simple decompression operation" advised by Kearney,[13] even in the absence of convulsions, and down to ordinary spinal puncture, there are des-

8. Sicherer, quoted by Ehrenfest, H.: Birth Injuries in the Child, New York, D. Appleton & Company, 1922, p. 66.

9. Paul, quoted by Ehrenfest, H.: Birth Injuries in the Child, New York, D. Appleton & Company, 1922, p. 140.

10. Jacobs, M. W.: Retinal Hemorrhage in the New-Born, J. A. M. A. **83:** 1641 (Nov. 22) 1924.

11. Paul, quoted by Ehrenfest, H.: Birth Injuries in the Child, New York, D. Appleton & Company, 1922, p. 67.

12. Henschen, Frazier, Doazen and Green, quoted by Ehrenfest, H.: Birth Injuries of the Child, 1922, p. 69.

13. Kearney, quoted by Ehrenfest, H.: Birth Injuries of the Child, 1922, p. 68.

perate measures devised to cope with the results of the excessive pressure exerted on the human central nervous system at birth.

Sharp and Maclaire [14] examined the cerebrospinal fluid of 500 infants within two days of their birth. They found the fluid bloody in 9 per cent. Of special interest is the fact that 395 of their series of 500 were normal births, and that of these 395 normally born infants, blood was found in the cerebrospinal fluid of twenty-two.

Such hemorrhages are indicative of intracranial damage. They speak for the fact that as a result of disproportion between the woman's pelvis and the child's head the mere event of being born afflicts large numbers with an injury to the brain. The injury, it is true, may be small enough not even to be detected years later by the histologic methods available. Every student of this subject, however, knows that even a small injury to the brain during the formative stage must, in years to come, be manifested by a large defect of behavior.

The increase in the knowledge of metabolic disorders has naturally stimulated the investigation of epilepsy from that standpoint. And much as must be allowed for the honest error and unconscious bias of the specialist, it is impossible to discard the opinion of growing numbers. And that opinion ascribes the cause of epilepsy in a large proportion of cases to a fundamental metabolic disturbance in the patient of one kind or another. So many and so varied are the kinds of metabolic disturbances discovered in epileptic patients by different investigators, that only a few can be pointed to in this place as exemplifying the direction of medical opinion on this question.[15] One need only glance at the formidable list of endocrinopathies associated with epilepsy in the Index Catalogue of the Library of the Surgeon-General's Office, U. S. Army,[16] to become aware of the growing prominence of metabolic disorders as a factor in epilepsy. That such constitutional defects no more originate de novo than do adherent ear lobules, webbed fingers, or other gross stigmas of epilepsy, goes without saying. Habit and experience easily

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14. Sharpe, W., and Maclaire, A. S.: Intracranial Hemorrhage in the New-Born, Surg. Gynec. Obst **38**:200, 1924; ibid. **41**:583, 1925; Intracranial Hemorrhage in the New-Born, J. A. M. A. **86**:332 (Jan. 30) 1926; Am. J. Obst. & Gynec. **9**:452, 1925; ibid. **8**:172, 1924. Maclaire, A. S.: Signs of Acute Proved Cases of Intracranial Hemorrhage in the New-Born, M. J. & Record **123**:215 (Feb. 17) 1926.

15. Patterson, H. A.: Haemotologic Pictures in Endocrine Syndromes Associated with Epilepsy, Am. J. Psychiat. **2**:427, 1923. Kraepelin, E.: Zur Epilepsiefrage, Ztschr. f. d. ges. Neurol. u. Psychiat. **52**:107, 1919. Frisch, F., and Weinberger, W.: Untersuchungen bei periodischer Epilepsie, Ztschr. f. d. ges. Neurol. u. Psychiat. **79**:576, 1922. Leahy, S. R.: Epileptiform Manifestations in Endocrine Disorders, New York State J. Med. **22**:8, 1922.

16. Index Catalogue of the Library of the Surgeon-General's Office, U. S. Army: Epilepsy, Endocrine, vol. 5, p. 316.

trace the latter defects to congenital and hereditary sources. One knows, however, that gross malformations may be but an expression of a faulty body-chemistry. And if that is true, then both gross malformation and a defective metabolism in a child may be the single result of a defective metabolism in a parent.

On the strength of the foregoing consideration, therefore, due respect must be had for the opinion of those observers who attribute more importance to hereditary factors than they do to injury at birth as a cause of epilepsy. It will be seen later that the causes of injury at birth themselves may be largely ascribed to hereditary influences.

When one contemplates the vastly intricate machinery of the human brain, the countless millions of pathways with their unnumbered communications; when one discerns—though ever so faintly—in each of the tenuous filaments and in their mysterious junctions a capacity for recording and manifesting in a thousand ways the thousand daily experiences of their possessor, one cannot but think that the progress of evolution of such a structure must necessitate a corresponding progress of evolution of certain metabolic processes of the pregnant woman. And if, in the course of evolution, the necessary gross increase in the size of the pelvic outlet has tarried behind the increase in the size of the child's brain, one may with reason apprehend that the necessary modifications of the prospective mother's metabolism, in correspondence with the larger and more intricate brain of the child, has exhibited a like inertia.

The discoveries in question are of assistance in explaining the large prevalence of such behavior defects as the epilepsies, the insanities, the neuroses and the vast variety of superstitious beliefs in the human species, as compared with the relative infrequency of such abnormalities in animals below man. The suspicion arises that the period which elapsed between the anthropoid ape and man must have been relatively brief. And it is difficult to escape from the melancholy conclusion that the increase in the size of the brain which characterized the unknown series between the ape and man must have been abnormally rapid, since it proceeded so far in advance of the necessary corresponding mechanical and metabolic changes of the pregnant female as to cripple great numbers on their entry into the world.

The process of molding an organ in correspondence to the tasks imposed on it by the exigencies of existence is, under natural conditions, relatively simple. Individual animals with ill-adapted organs are eliminated. The most favorable variations of the organ are thus perpetuated by the survival of their possessors. Up to recent years the neuromuscular disabilities produced by an excessive disproportion in the relative sizes of the woman's pelvis and the child's head have been maintained in a certain status quo by the natural elimination of the

most ill-adapted mothers and children.[17] Within our own times, however, the biologic momentum of the forces which have made for the large size of the human brain has manifested itself in a form which tends to subvert the protective process of the natural elimination of the unfit. The art of obstetrics and gynecology is one of the most remarkable manifestations of the progress of human intelligence. This art enables the mother whose pelvis is too narrow, as well as the child whose head is too large, to survive; and, with the help of the other medical arts, both of these defective beings are endowed with the privilege of inflicting their defects on increasing numbers in successive generations. It is too early as yet to behold these increased numbers; but the rational physician must see that his successors are to be confronted with an increasingly difficult problem. The evidence of intra-ocular and subarachnoid hemorrhage alone points to a crippling of about one third of human beings born; and what with the more obvious injuries of the brain at birth, which result in the hemiplegias, the diplegias and other palsies, the number of human beings crippled from birth must be considerably greater. Yet this number takes no account of the newborn infants predestined to disease by a faulty metabolism of the parents. And if, after a thousand ages of rigorous elimination of the unfit, one third or more of the human beings born are still crippled by the mere event of birth, what must happen when the process of natural elimination is eliminated by the genius of man?

Lest one be lulled into a sense of false security, let another fact be considered.

It is a universal law of all aggregates that the degree of their stability is in an inverse ratio to that of their complexity. This is true of mechanical devices as well as of chemical compounds. Every manufacturer is aware of the trouble and expense involved in maintaining a complicated machine in order. The larger the number of parts, the greater are the chances of the machine to get out of order. And the merest acquaintance with chemistry teaches the lesson that the greater the number of atoms in a molecule the more readily it is disrupted. If that is true, what must one think of the effect of the rapidly increasing complexity and multiplicity of cerebral functions with the rapid progress of civilization? If organic functioning implies certain chemical and physical readjustments, then an increase in the complexity and

17. The momentum of fashion or the spirit of humanity may be depended on to raise champions in the cause of the unfortunates. In his preface, H. Ehrenfest (Birth Injuries of the Child, 1922), quotes Dr. Grace Meig's charge that "at least 15,000 women die in the United States from conditions almost entirely preventable, caused by childbirth" and that childbirth was almost as hazardous in 1913 as in 1900. Saenger, H.: Ueber die Enstehung intrakranialer Blutungen beim Neugeborenen, Monatschr. f. Geburtsh. u. Gynäk. **65**:258, 1923-1924.

number of cerebral functions must imply a correspondingly complex and multiform readjustment of the tissue elements of the nervous system. Such increased complexity and multiplicity, in their turn, imply an increased delicacy of balance. In the face of the numerous agencies for crippling the mechanism of that balance at birth and of perpetuating the effects by the humanitarian intervention of the medical profession, what must happen with the increasing demands on the delicacy of that balance?

A more cheerful side of the problem in hand is discernible in another discovery made some years ago. Of itself a merely curious physiologic observation, the discovery in question is of greater significance to the neuropsychiatrist than to the physiologist, and of still greater significance to the educator. For the purpose of studying certain phases of parathyroprivoid tetany, Hammett [18] operated on a number of rats. Ninety were of the standard wild stock; while ninety-six were laboratory animals, such as had been fed and handled by the laboratory workers, so that the animals showed no fear or anxiety in the presence of human beings. As a result of the operation, 79 per cent of the wild rats rapidly developed tetany and died; 87 per cent of the tame rats survived.

A fact of surpassing importance at once becomes manifest: that a certain mental and muscular training of the animals previous to the operation was instrumental in overcoming so definite an organic defect as a diminution or absence of parathyroid influence. The observation finds its parallel in a hundred phases of everyday life. The numerous annoyances and vicissitudes which tend from hour to hour to distort the chemical, physical and mechanical equilibrium of the body, are overcome by habits of discipline and by an ability to reason from cause to effect. Those who are not trained to the fearless facing of facts succumb to one of the hundred aspects of the tetanic state—the neuroses, the epilepsies, the hysterias and the other sinister forms of the descent of man. For it must be borne in mind that the neuromuscular manifestations of tetany are to a greater or less degree reproduced in every nervous and mental disease characterized by the plexus of abnormal muscular activity and by an abnormal sensory or conscious state. In a previous publication,[19] I showed the manner in which the tetanic state, when superimposed on other neuromuscular abnormalities, exaggerates enormously their manifestations. If, therefore, an animal that must surely die of tetany is saved by a previous mental and muscular train-

18. Hammett, F. S.: Studies in the Thyroid Apparatus, Am. J. Physiol. **56:** 196, 1921.

19. Rosett, Joshua: The Experimental Production of Rigidity, of Abnormal Involuntary Movements and of Abnormal States of Consciousness in Man, Brain **47:**293, 1924.

ing of a certain kind, it can be only because that state is so common under natural conditions that the animal organism is by nature armed with potentialities for overcoming it. That these potentialities may be enormously developed by training will be seen from the experiments on epileptic persons to be cited later in this paper. Outside of any radical improvements in the processes of pregnancy and childbirth, the hope of counteracting the evils sketched in the preceding pages lies largely in the recognition of these potentialities in the human being by the educator and the administrator.

PREMISES

The Scope of the Subject.—It will be shown in the forthcoming study that the epileptic seizure is not of itself an abnormal phenomenon, but that it is an abnormal facility of the normal process by which an inhibition of the sensory or conscious state results in muscular activity. In the reduction and disintegration of the conscious state and the consequent hallucinations which mark the onset of the seizure, there will, from such a point of view, be discerned significance bearing on the mechanism of normal thought and imagery; and in the rigidity, the convulsions, the flaccid paralysis and the other motor phenomena of the seizure will be discovered a number of facts which may be utilized for the understanding of normal action.

For convenience of description and discussion the classic division of the seizure into stages is amplified as follows: (1) the reduction of the sensory or conscious state, (2) unconsciousness, (3) momentary muscular relaxation, (4) general muscular rigidity, (5) convulsions, (6) the appearance of dorsiflexion of the great toe on plantar stimulation, (7) flaccid paralysis and (8) recovery.

It will appear that these several stages of the seizure result from the uniform operation of a wave of inhibition of nerve conduction. That wave will be shown to proceed in classic cases in an orderly manner along the several anatomic units of the sensory nerve pathway, from the receptors to the cerebrum and thence by the efferent pathways to the motor neurons of the lower neuraxis, and so to the muscles. The study is facilitated by reference to the diagram (fig. 1). It will be shown at the same time that such a procession of a wave of inhibition is likewise operative in the normal processes of thought and action. It will be pointed out how the converse of this phenomenon may be utilized in the solution of certain problems hitherto obscure, and attention will be called to the shortcomings of its application to the solution of other problems.

Inhibition.—It is a prevalent notion that when a normal animal, under natural conditions of life, is exposed to the action of a stimulus, the process of nerve conduction is set going as a rule; and that the inhibition of such conduction is due to certain exceptional circumstances.

That the reverse of the prevalent notion regarding the process of inhibition is true, appears from the following considerations:

In the movements of the animal, every process of nerve conduction is simultaneous with a corresponding amount of nerve inhibition. This

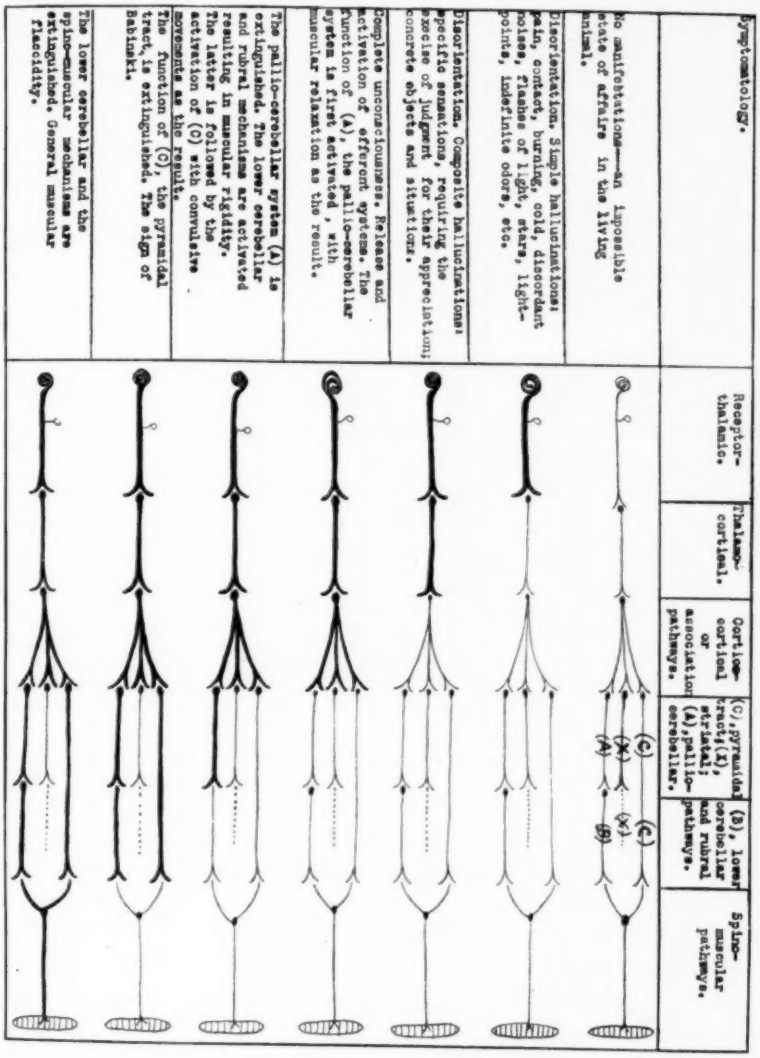

Fig. 1.—A diagram intended to illustrate the march of inhibition along the cerebral nerve pathway, from the receptors to the muscles, in the epileptic seizure. The dark line, which is intended to designate the degree and extent of inhibition, should be less dark if the same diagram is to be applied to processes of normal thought and normal action. The striatal pathway is marked (*X*), being an unknown factor.

is plainly observed in the reciprocal action of antagonistic muscles—in the diminished tonicity of a muscle when, by the contraction of its antagonist, the limb is pulled on with the production of movement as the result.

The number of stimuli to which the organism is exposed every moment of its life is practically infinite. The animal, however, responds to only a small number of these. The fact that by far the greater number of stimuli to which the living body is exposed are neither registered as sensations nor responded to by muscular or glandular activity is indicative of the fact that although stimuli must have impinged on the nerve receptors, any nerve impulses which may have been initiated were extinguished before proceeding for any considerable distance along the nerve pathway. Such an extinction of a nerve impulse is known as inhibition. The exact manner of the operation of this process is not dealt with in this work. Certain special features of inhibition will be discussed later.

In the forthcoming study the term inhibition is, on the strength of the foregoing considerations, employed in instances in which a normal nerve exposed to stimulation is found to be refractory.

The Conscious State.—A remarkable feature of the attitude toward the conscious state is that both its presence and its absence are equally perplexing. Since time immemorial both have been an inexhaustible source of wonder and speculation. Superstition and philosophy have alike contributed to the retardation of knowledge regarding the conscious state. An endless procession of obscurantists, arriving from every walk of life, appear to have conspired in deepening mystery into mysticism and in perfecting ignorance on this point. The psychologist, according to his temper, either assumes a position of virtuous agnosticism; or hints at a soul; or speaks of a mind stuff; or by a singular turn of logic denies the existence of consciousness and by the same token transfers its seat from the cerebrum to the muscles.

Before proceeding with the study of the epileptic seizure, a brief account of what constitutes the sensory or conscious state is, therefore, essential.

Anatomically, a sensory nerve pathway differs from one which conveys nonsensory impulses in that the efferent arm of the first begins in the cerebrum while that of the other may begin at any level below the cerebrum.

Since a nerve impulse becomes sensory only when it enters the cerebrum, the answer to the question, "What are the special features of a nerve impulse by virtue of which it comes to be distinguished as sensory?" must lie in certain characteristics which distinguish the cerebrum from the lower neuraxis.

1. The area of cross-section of the sum of nerve fibers which enter and leave the cerebrum is about 4 or 5 sq. cm. The area of cross-section of the cerebrum itself, in its widest part, is much greater. Each entering or emerging nerve fiber must therefore, within the cerebrum, be in relation to a great number of fibers. A nerve impulse proceeding along a single fiber, say in the mesial fillet, must therefore be potentially capable of being communicated to a great number of fibers within the cerebrum. Moreover, according to the all or none principle of nerve conduction, the quantitative value of the impulse proceeding along each of the many fibers in the cerebrum, must be as great as it was in the single fiber along which it was first propagated. If the nerve impulse is considered as a change of some sort, as a given disturbance in the constitution of the organism, then that constitutional disturbance is much amplified by its entry into the cerebrum.

2. The basic cause of which memory or learning is the effect is by common agreement conceived to be a plasticity of substance which permits of its more or less permanent physical, chemical and mechanical modification by the passage of a nerve impulse. Since the cerebrum is the only part of the nervous system which is demonstrably the seat of learning, one must conclude that its pathways are more or less permanently modified in certain ways by the passage of nerve impulses.

3. One knows that among the conditions which make for a particular modification of the reaction of an animal to a given situation is its previous experience not only with that, but with other situations as well. This justifies the conclusion that a nerve impulse in passing along the cerebral pathways is itself modified in correspondence with the modifications wrought in those pathways by all sorts of nerve impulses.

A simile, distant though it be, will help to illustrate the case. The constitutional disturbance which consists in the passage of a nerve impulse may be compared to the disturbances—electrical, thermal and others—that take place in a vehicle which travels along a road. If the road is smooth and made of a hard substance, the vehicle will suffer little disturbance. If, on the other hand, it is made of a plastic substance, like asphalt, the physical mechanical and chemical changes in the vehicle will correspond to the impressions left on the road by the previous passage over it of all sorts of bodies. The onward progress of the vehicle is modified in definite ways which correspond to the past experiences of the roadbed.

4. From the observation of behavior one learns the following facts: Within a very wide range of situations to which the hungry person may be exposed, the resulting sensations will be mainly those pertaining to food. This is similarly true of the thirsty person with respect to drink, of the exposed person with respect to cover and shelter, of the sex-hungry person with respect to sex, of the drug-hungry addict with respect to the drug, of the person in need of defecation or urination

with respect to those acts and so on throughout the range of the organic needs of moment.

One is therefore forced to the conclusion that, much as a kind of physical, chemical and mechanical register, no matter what the disturbances or stimuli to which the person (or the animal) may be exposed, the cerebrum registers only those stimuli which have reference to certain disturbed chemical, physical and mechanical potentials of the constitution.*

There are, then, as the distinctive functions of the cerebrum the following: (1) an amplification of that constitutional disturbance which is represented by the nerve impulse, (2) a plasticity of substance which makes it modifiable in definite ways by the passage of nerve impulses resulting from different situations, (3) a capacity for changing the character of any one nerve impulse in accordance with the modifications that its substance has undergone by the previous passage of nerve impulses of all kinds and (4) a capacity for selecting among a crowd of stimuli to which the organism is exposed only those which pertain to certain disturbed constitutional balances at that moment.

Nerve impulses which are subject to the functions outlined are distinguished as sensory in contrast to nonsensory nerve impulses, which are not subject to such functions.

With this definition of the sensory state one may now proceed to the study of the first stage of the epileptic seizure.

REDUCTION AND DISINTEGRATION OF THE SENSORY STATE

Simple and Composite Hallucinations.—The prominent phenomena of the first part of the epileptic seizure consist in disorientation, and, in a number of cases, in simple and in composite hallucinations. That these three symptoms are associated with a disability of respectively lower and higher portions of the sensory nerve pathway may be ascertained by the examination of certain instances of actual loss of different portions of the sensory pathway where the same symptoms occur.

The lowest portion of the sensory pathway is the sensory receptor, and the fact need hardly be mentioned that the loss of the sensory receptor in any portion of the sensory sphere is accompanied by a corresponding degree of disorientation in that particular sphere.

Physicians are familiar with the so-called reference-phenomena —stump-hallucinations—after the amputation of a limb. The patient may complain of a sense of pain, tingling, pulling, pressure, heat and cold in limbs that no longer exist. The phenomenon is usually explained by the irritation of the severed ends of the nerves. The same symptoms, however, occur regularly during the reduction of the sensory state in tetany induced by overbreathing, and cannot in this condition be explained by an irritation of the nerves. Whatever the cause may be,

these sensations are not in correspondence with reality and must be considered, therefore, as hallucinations. It will be noted that the distinctive feature of these hallucinations is the simple or protective character of the sensations of which they are constituted. The hallucinations which sometimes occur in the course of atrophy of the optic nerve are similarly marked by the character of simplicity. Dr. Schoenberg, of New York, from his files furnished a number of such instances. The patients see light points, rays, flashes, shapeless masses of light and stars. The sensation of discordant noises in diseases of the first part of the auditory pathway has the same elementary character.

A review of the literature of the early part of this century on the subject of cerebral disease or injury followed by definite disturbances of sensation, with hallucinations, reveals a paucity of both definite localization and definite mental symptomatology. A remarkable case of abscess of the posterior part of the left cerebral hemisphere involving the second and third temporosphenoidal convolutions is reported by Bramwell.[20] Among the symptoms of this patient were hemianopia or rather hemichromatopsia and convulsive seizures preceded by an hallucination of flashes of light. The patient was too ill to give information regarding the localization of the hallucinations in the field of vision. He died, and the gross sections of the cerebrum revealed the extent of the abscess. The author thought that the visual radiation on the left side must have been injured by pressure of the pus. The illustrations which accompany the report, however, show definitely a strand of sound tissue at least 6 mm. thick between the ventricle immediately posterior to the pulvinar of the thalamus mesially and the wall of the abscess laterally. It will be remembered that the thickness of the optic radiation together with the layer of callosal fibers and the ventricular ependyma in that region hardly exceeds 3 mm. The function of the optic radiation was almost certainly intact. Another postmortem observation, however, gives the clue to the defect of vision and the elementary nature of the hallucinations: a purulent meningitis at the optic chiasma.

In contrast to such simple hallucinations are others of a highly composite character, which are associated with disease of a higher portion of the sensory pathway than that implied in the preceding instances. Cushing's[21] cases of tumor of the brain clearly illustrate this point. He observed composite visual hallucinations in thirteen of a series of fifty-nine patients. The hallucinations of these patients consisted not merely of the sensation of light, but of that of light modified by and

20. Bramwell, E.: Cerebral Abscess Secondary to Bronchiectasis, Rev. Neurol. & Psychiat. **8**:77, 1910.

21. Cushing, H.: Distortions of the Visual Fields in Cases of Brain Tumor, Brain **44**:341, 1922.

compounded with other sensations—they were, in other words, constituted of concrete objects and concrete situations. Regarding them, the author remarked that, "Certainly they bear some relation to the damaged geniculo-calcarine radiation, for in this series, whenever its situation has been mentioned, the hallucination has always been referred by the patient to the side opposite that occupied by the lesion, in other words, in the defective fields." That one of the conditions for the existence of these hallucinations is a disability of the peripheral-ward portion of the sensory pathway is of course seen from the coexistence of a corresponding degree of disorientation in the sphere of the particular sensation which is most prominent in the hallucination. In Cushing's cases, this degree of disorientation is measurable by means of the perimeter. One of these patients (case 7) illustrates the same facts in a different sphere of sensation. Immediately after the birth of her child, in 1912, this patient lost the sense of smell. Two years later, she frequently had olfactory hallucinations, occasionally disagreeable ones.

Since in visual hallucinations a definite part of the lower optic pathways and of the optic radiation is excluded from function, the composite hallucinations must be a manifestation of the function of the next higher units of the nerve pathway. Those neurons are known anatomically to be the fibers which stretch between the calcarine and other portions of the cerebral cortex—the association pathways.

The following instance, recently observed in the Vanderbilt Clinic, illustrates the dependence of the clarity and definiteness of composite hallucinations on the degree of completeness to which function is absent in the peripheral-ward neurons of the sensory pathway:

> J. R., a plumber, aged 41, smoked fifteen cigars daily for a number of years. About July, 1927, his vision, in the course of a few days, became somewhat dim. Since then, whenever he closes his eyes he sees visions of horses, men, houses and other concrete objects. The visions are not clear, their outline is indefinite and they are translucent.

The optic pathways in this patient are largely preserved and the manifestation of function of the association pathways is correspondingly weak.

Hallucinations in Epilepsy.—In the stage of disorientation of epilepsy, when composite hallucinations occur, they are frequently preceded by hallucinations constituted of the simple protective sensations. Thus, the vision of a person or of an animal, the sound of a human voice, the ringing of church bells, or the sensation of movement in definite directions and for definite distances, are generally preceded by flashes of light, by hissing or booming noises, or by sensations of pain, tightness, pulling or twisting in the limbs.

In three symptoms of the first stage of the seizure—the diminished awareness of the surroundings, the simple and the composite hallucina-

tions—one can follow the suspension of nerve function in the sensory pathway from the receptors to the sensation areas of the cerebral cortex. It is a fact, which will prove of importance in the understanding of the processes of thought and imagery, that in this stage of the epileptic seizure the inhibition of sensory function is generally unequally distributed. The patient, in other words, may be disoriented with respect to certain conditions and largely oriented with respect to others. The vestibular apparatus is most often affected, while orientation in other fields is still preserved. The patient then complains of dizziness. Vision may be extinguished while the rest of the sensory apparatus may still be active. The patient may then complain of darkness. A difficulty is presented by instances in which there occurs an extinction of certain sensory functions with which one is not well acquainted, as for instance that of the resistance of tissues. Following is an example:

S. V., aged 13, was afflicted with minor and major epilepsy all his life. His mother and several members of her family had had attacks of benign stupor. His father was a criminal and a pervert. I induced minor and major seizures in this patient—the latter were mild—on a number of occasions. The onset of the seizure was signalled by the following complaint: "I feel as if everything is dropping away from me. There is nothing left of me. I don't feel my body. I am nothing."

In a discussion on brain abscess at a joint meeting of the Sections on Otology and Neurology of the New York Academy of Medicine, Jan. 11, 1929, Foster Kennedy called attention to the following remarkable fact. In abscess, or other diseases of the temporal lobe of the cerebrum, when composite hallucinations take place in the defective field of vision, the patient is aware of the unreality of the appearances, no matter how clear they may be. Thus, the patient may inform one that he sees clearly a horse in the blind field of his vision. Asked whether the horse is really there, he will reply that it is not, and he will even offer rational arguments to this effect.

The phenomenon is of course due to the fact that although the patient is disoriented in a certain portion of his sensory sphere, he is oriented in others and so is enabled to judge of the nature and extent of his sensory defect.

The Minor Seizure.—The seizure may terminate at this point. The instances in which hallucinations occur in such minor seizures show, by the manner of recovery, the correctness of the assumption regarding the order of the procession of the inhibitory wave along the sensory pathway. The order of disappearance of the symptoms is the reverse of that of the onset. After the disappearance of the composite hallucination the patient may still be dizzy, or he may complain that his vision is dim or that he has a "funny" sensation in the finger or toe.

Such a minor seizure, it will be observed, is purely sensory. In the course of a large number of experiments on the induction of the epileptic seizure, I have seen minor seizures in patients with muscular phenomena in whom the latter had not been observed before the experiment. The simple reason is that the patients were undressed for the

better observation of the effects of overbreathing, and the motor phenomena consisted of small tremors of such muscles as the intercostals, the abdominal muscles, the muscles of the arms and thighs—parts that are usually covered. On the other hand, it is certain that in a number of patients during the minor seizure there is not a sign of muscular spasm. The latter fact is significant as showing that the wave of inhibition may proceed a certain distance along the afferent neurons and recede before reaching the efferent arm of the long reflex arc. It will be seen later that the application of this fact to the mechanism of imagery and thought makes for a simple conception of the process.

Sleep.—That the functional suspension of the sensory system which is productive of disorientation and hallucinations is not of itself abnormal may be gathered from its presence during the first stage of sleep. Any one who will take the trouble to observe himself in the process of falling asleep will easily record the following: A gradually deepening anesthesia of sight and hearing, a numbness and weight of the limbs, increasing errors in the estimation of the direction and extent of movement. The result is disorientation. This may be followed by hallucinations. In the order of the appearance of these symptoms one can trace the extinction of the several units of the sensory nerve pathway from the receptors to the cerebral cortex.

In this normal process, moreover, the extinction of the sensory pathway is, just as in the first stages of epilepsy, generally unequally distributed. Orientation in certain sensory spheres may persist long after it disappears in others. This is attested by the fact that the person, after a little training, is able to observe himself in that state and to give a good account of his observations afterward.

Combinations of Actual and Functional Suspension of the Lower Portion of the Sensory Pathway.—The symptoms of a combination of an actual loss of the peripheral-ward portion of the sensory pathway with the inhibition of its function, such as that which takes place in falling asleep, affords further corroboration of the correctness of the point of view here put forth. The following is an example:

S. W. K. has had partial optic atrophy for the past twenty-nine years. He cannot fall asleep, as he states his case, except after the appearance of a large yellow flame, and he looks for its appearance as signifying the approach of sleep. It will readily be seen that what actually happens is that at a certain stage in the process of falling asleep he experiences the simple hallucination. That the stage is an early one may be gathered from the fact that he is sufficiently oriented in spheres of other than the visual sense to be able to expect the vision as a welcome sign of sleep. The reason for the early extinction of the function of the optic nerve may be safely ascribed to the small amount of function preserved. Compound hallucinations may follow, but they never precede the appearance of the flame in this patient.

THE SENSORY PHENOMENA OF THE STATE OF ATTENTION

The Two Phases of Attention.—A fact which might be of interest to the student of the difference in the psychologies of different nations is that in different languages the state of attention is signified either by its sensory or by its muscular manifestations. Thus for example, the English and French "Attention" plainly refers to its muscular phase; while the German "Aufmerksamkeit" and the Slavic "Vnimaniye" refer to its sensory phase—a singular one-sidedness of mentality that deserves investigation.

The Anesthesia of Attention.—The sensory phase of attention consists, in psychologic terms, of a small and intense amount of consciousness which merges into a much larger sphere of unconsciousness. Translated into the more concrete physiologic terms, the sensory phase of attention consists in the following: At any one moment, a small portion of the sensory nerve apparatus is patent to stimulation; while in the much larger remaining portion of the sensory nerve system, conduction is largely inhibited, and stimulation, therefore, is relatively ineffective.

The absorbed person is indeed largely unconscious and anesthetic. He may not hear when called by name; he may not see objects in his field of vision; he may not feel when he is tugged on the sleeve. Only a few sensory nerve pathways appear to be open to stimulation; and so intense may be the concentration of the attention, so few the nerve pathways capable of conduction that the person is at any moment on the verge of complete unconsciousness.

Genius and Epilepsy.—The foregoing, which is familiar enough, may be utilized in explaining the occurrence of epileptic seizures, complete or fragmentary, in persons of outstanding ability in almost every phase of life. A critical review of the life of Julius Caesar [22] discovers a towering mentality in a person possessed of an extraordinary number of virtues. He had epileptic seizures.[23] Everybody who has carefully studied the intellectual capacity and the character of epileptic persons has discovered a low grade of mentality and a character traversed by many serious defects. Most of the 2,000 patients in the Craig Colony for Epileptics are classed as morons. Yet from Moses [24] to St. Paul,[25] and from Ignatius Loyola [26] to certain well known scientists of our own day, hun-

22. Froude, J. A.: Caesar, New York, Charles Scribner's Sons, 1902.

23. Glough: Plutarch's Lives, New York, A. H. Burt, Vol. 4, p. 105. "He was distempered in the head and subject to an epilepsy, which it is said first seized him at Corduba."

24. Exodus III, 2: "And he looked and, behold, the bush burned with fire and the bush was not consumed."

25. The Acts IX, 4: "And he fell to the earth and heard a voice."

26. Autobiography of St. Ignatius Loyola, 1491-1556, 1900, New York, J. F. X O'Connor.

dreds of able leaders in all walks of life have seen visions, heard voices, have "fallen upon the ground." An understanding of the mechanism of the state of attention serves to reconcile the seemingly contradictory phenomena. The fact is that, although an epileptic person cannot attain the status of a genius, the genius, the person eminently capable of the highest degree of concentration of attention, is by virtue of this fact subject to epileptoid seizures. In the functional disability of the optic nerve during a state of attention that makes no use of that nerve, one is not surprised to find a manifestation of the function of the next part of the visual pathway—flashes of light and color, dim and indefinite shapes, the kaleidoscopic play of light rays and light points. The latter are interpreted by the subject according to his particular temper and education. Moreover, in a concentration of attention that makes no use of the optic radiation, one is not surprised to find symptoms of disability of that part of the pathway. One of these symptoms, as seen from cases of actual injury of the optic radiation, is a manifestation of the function of the association systems—composite visual hallucinations. What is true of the part played by the visual pathway in such cases is likewise true of the other sensory pathways. Furthermore, it will be seen later that what is true of the epileptic seizure and of the state of attention regarding the action of the wave of inhibition on the afferent pathways is true as well of the efferent pathways.

The manner in which the concentration of attention in states of surprise, results, in normal persons, in a complete miniature of an epileptic seizure, with all its sensory and motor manifestations—the normal epileptoid reaction—has been described in a previous publication.[27]

The approximate scope of a consciousness present in states of intense concentration of attention may be gathered from a number of popular expressions which refer directly or indirectly to the sensory defect. "I was so surprised that I did not know what I was doing," "I was dumbfounded," and many other expressions of the kind have reference to a degree of extinction of function of the sensory pathways.

The State of Attention and Epileptic and Epileptoid Phenomena.—How closely the epileptic seizure is related to the normal state of attention may be gathered from the following instance:

> J. P., aged 18, a victim of traumatic epilepsy of a very severe type, was extremely sensitive on the point of his appearance, being very fastidious about his dress, about the condition of his finger-nails, the whiteness of his collar, etc. I could always induce a seizure in this patient by concentrating his attention on his appearance, thus: "J., I must compliment you on the masterly way in which you arrange your necktie. It is a beautiful necktie besides, and it matches your complexion perfectly." A blank smile would overspread his face and automatism

27. Rosett, Joshua: The Mechanism and the Fundamental Cause of the Epilepsies, Arch. Neurol. & Psychiat. **9**:689 (June) 1923.

followed. The "psychic equivalent" sometimes terminated in a violent major seizure.

A behavior strikingly similar to that of the epileptic patient just cited may be commonly observed in most people as a result of the concentration of attention on themselves by similar means. They are rendered semiconscious by the flattery of words or by that of a small gift, as may be easily gathered from their stupid elation and the subsequent senseless behavior. The implication of "a gift doth blind the eyes of the wise and pervert the words of the righteous" is that of a degree of insensibility and of abnormal muscular phenomena produced by a concentration of the attention on a vulnerable point. The phenomenon is that of an epileptic seizure somewhat thinly spread out.

A Biologic Interpretation of the Sensory Phenomena of Attention: Anatomic Facts.—It will be readily seen that the inhibition of nerve conduction which is operative in states of attention must be one of the underlying conditions of life. Bombarded by an infinite number of stimuli, the organism must record and respond only to those which are conducive to a continuance of its life as an individual and as a member of a race. And all useless stimulation must be prevented from initiating that constitutional disturbance which is represented by the process of nerve conduction. The probable mechanism by means of which the organism is enabled to select amid a crowd of stimuli only a few, which then enter the sphere of consciousness as sensations, has been suggested before under the heading of "The conscious state." The hypothesis that the organism is normally "sensitive" only to those stimuli which have reference to corresponding disturbed potentials in the body is strengthened by certain anatomic facts, one of which is offered here by way of illustration.

The experiments of Adrian,[28] Lucas,[29] Sherrington[30] and a number of other investigators have established the fact that modification of a nerve impulse is especially liable to take place in the situation of junction between nerve and muscle or between nerve and nerve. Of the stimuli by which the organism is bombarded, there are certain ones to which it must continually respond and others from which the organism can afford to select only a few to which it will respond. An example of the one is that of gravitation. An example of the other is that of sound. In accordance with the physiologic principle of inhibition, one finds the following anatomic facts: The vestibular nerve passes from its receptor into the nuclei of the vestibular area of the medulla. From these nuclei one set of fibers ascends to the cerebellum and another descends into the spinal cord. There is thus but a single interruption

28. Adrian, E. D.: Some Recent Work on Inhibition, Brain **47**:399, 1924.

29. Lucas, K.: The Conduction of the Nervous Impulse, New York, Longmans, Greene and Company, 1917.

30. Sherrington, C.: The Integrative Action of the Nervous System, Connecticut, Yale University Press, 1904, p. 17.

in the pathway, affording but small chance for the inhibition of the nerve impulses which register the relation of the organism to the horizon. In contrast to the course of the vestibular nerve is that of the auditory portion of the eighth. Following are some of the interruptions in its course: the nucleus of the eighth nerve, one or more nuclei of the trapezoid body, the inferior colliculus and the internal geniculate body of the optic thalamus. Such a number of nerve junctions must afford ample opportunity for the inhibition of large numbers of nerve impulses produced by sound stimuli, many of which are unnecessary to the life of the organism.

The Sensory Phase of Imagery and Thought.—Imagery and thought constitute a state of attention which deals with and is concentrated on past experience. It is therefore the function of the repositories of the compound memories of such experiences—the association systems of the cerebrum. It has been seen that a manifestation of the function of these pathways in the form of hallucinations is subject to the condition that the activity of the lower sensory pathways be suspended. And the pertinence of the application of this principle to the operation of thought may be discerned from the fact that thinking is difficult or impossible during the distracting activity of the sensory receptors. The person intent on his thoughts, for this reason, seeks isolation. It is a matter of common experience that visual memories are the more vivid when the eyes are closed than when open; or with the eyes open, when the eyeballs are turned upward, so as to escape direct vision; or when the visual axes of the person whose eyes are wide open are parallel so that the gaze is into infinity. The person who wishes to recollect the memory of an odor by smelling a certain substance, smells at it then removes it from his nose—obviously in order to do away with the activity of the lower stretch of the olfactory pathway and thus permit the manifestation of the higher olfactory neurons. The result is that from moment to moment each element of a series of thoughts has a corresponding element of anesthesia—with each element of the function of the higher sensory neurons there goes an element of anesthesia of the lower neurons of the sensory pathway. Since, however, the elements of thought are constituted mostly of composite memories of sensations, the corresponding anesthesia of the lower sensory neurons is correspondingly widespread in many or in all spheres of sensation. Thus composite visual imagery, when sufficiently intense, is not only associated with a corresponding disability of the retina and optic nerve, but with a partial anesthesia which may embrace the entire receptive field.

It has been shown that the selective action of the state of attention arises from the fact that, normally, nerve structures are open only to the kinds of excitation which have reference to certain disturbed poten-

tials in the organism. Thus, the thoughts of the hungry person dwell mainly on food; the thoughts of the sex-hungry person are dominated by sex. In the vast complication of nerve functions it is impossible to trace the reference of each fleeting element of thought to the source of the disturbed organic potential from which it arose. But what is true of the operation of the state of attention with relation to the obvious needs of the body must likewise be true of the operation of the mechanism of attention with respect to the needs which are not obvious. Thus, in Pavlov's experiments the presence of food before the hungry animal sets going nerve processes which result in the flow of saliva; but in the trained animal the ringing of a bell has reference to food; and in the further trained animal the beating of a metronome has reference to the ringing of a bell, which in turn has reference to food. In the human being such a series may be very long and complicated. That under normal conditions, however, no nerve conduction takes place in the living animal except as having some reference to a disturbed potential of the constitution is certain. Otherwise, the animal must respond to irrelevant as well as to relevant stimulation—a state of affairs under which no life is possible.

For each thought, and for the particular intensity of each thought, therefore, there is a corresponding disturbed potential in the body. In the light of what is known regarding the sequence of events in the first stage of the epileptic seizure and in other allied conditions, the operation of a disturbed constitutional potential which gives rise to a momentary thought is a momentary widespread inhibition of the sensory pathway of a certain degree, extending as far as the association systems of the cerebrum. One consequence of the ensuing partial disability of the lower sensory pathway is a certain degree of disorientation of the person in relation to his surroundings. Another consequence is the manifestation of function of the association pathways—the repositories of composite sensory memories. Moreover, it has been seen that the hallucinations which sometimes occur in diseases which injure only a small part of a given lower sensory pathway are correspondingly faint (case of J. R., toxic amblyopia). This is in harmony with the fact that the anesthesia of the lower sensory pathways during ordinary processes of thought being incomplete, the images of normal thought are less vivid than are the normal hallucinations of sleep. While the thinking person is in this respect at a disadvantage, he is at advantage in another respect; the function of his lower sensory pathways being but incompletely in abeyance, he is to that extent oriented; and being to a certain extent oriented, his activities are to the same extent in correspondence with the conditions of his environment. Hence it is that hallucinations are,

with respect to the person's environment, purposeless, while thought is to a certain extent, in the same respect, purposeful.

In a discussion of the inhibition phenomena of somnolence and sleep which ensue in Pavlov's experiments as a result of prolonging the interval between the exposures of a conditioned and an unconditioned stimulus, Adie[31] said: "The main factor involved in the hypothesis is that every more or less prolonged stimulus to the cortex . . . if not accompanied by stimuli to other parts . . . leads inevitably to somnolence and sleep." The apparent contradiction involved in the statement disappears when the following is considered:

That most of the sensory system of the hungry dog in expectation of food is inhibited, must be clear from the facts discussed regarding the anesthesia which is a condition of the state of attention. Under the circumstances of the carefully conducted experiment the dog is, therefore, on the verge of unconsciousness in any case. The unusual postponement of the appearance of food further concentrates an already intensely concentrated attention; in other words, the peripheral sensory apparatus and most of the cerebral association systems are further inhibited. And such a state of affairs constitutes sleep. Theoretically, a further refinement of these experiments should make it possible to produce in these dogs not only sleep, but complete unconsciousness and convulsions.

In the same manner that the functional disability of the lower sensory neurons which gives rise to hallucinations in the epileptic seizure may recede, without reaching as far as the efferent cerebral pathways, so may the same functional disability of these pathways recede in the process of thought and imagery. The latter in such a case remains purely or mainly a sensory phenomenon. In each case the extinction of function may proceed further along the cerebral pathways. The consequences of such an event will now be dealt with.

THE ACTIVATION OF THE EFFERENT SYSTEMS

The body may, merely by the laws of its own constitution, do much that its own mind is amazed at.

B. Spinoza.

Methods and Technic.—The seizures were induced by means of voluntary hyperpnea described in a previous publication.[30] In the work done at the Craig Colony for Epileptics, the use of the metronome and the expansometer was dispensed with. The moving picture camera was trained on the patient, but was not operated, for reasons of economy, until the beginning of the seizure. The first few moments of the seizure are not, therefore, shown in most of the pictures. The reels of the Ciné-Kodak—the machine used—are only 100 feet long, and the pictures are therefore short of the end of the more prolonged seizures. A number of separate pictures were subsequently projected and the outlines drawn.

The Stage of Unconsciousness.—No matter how great the disorientation may be during the first stages of the epileptic seizure, the afferent nonsensory apparatus is still active. This is evidenced by the fact that

31. Adie, W. J.: Idiopathic Narcolepsy, Brain **49**:257, 1926.

the patient, although largely anesthetic, can stand, walk and execute a number of movements. If the wave of inhibition proceeds farther, however, the entire somatic afferent nerve apparatus is extinguished. The hallucinations disappear. The patient becomes utterly unconscious and, being unable to balance himself in the upright posture, he falls.

The Stage of Momentary Muscular Relaxation and of General Muscular Rigidity.—By the practice of my method of inducing the seizure by means of hyperpnea, I was able to observe the patients undressed and in the comfortable prone position. As soon as unconsciousness ensued, a general muscular relaxation could be observed for a brief moment. The musculature of the patient sinks in, and if the hand of the observer has been grasping a patient's limb, its muscles are felt to be flaccid. Immediately after, however, the entire musculature of the patient bounds into a state of rigidity. The distribution of this rigidity is, as far as I could ascertain, equal on all sides of the limbs. The posture of the patient is that of tetany.

It is of course possible that a complete functional "de-afferentation" of the person may be the cause of the momentary muscular flaccidity. Sherrington showed such an effect of actual de-afferentation on the decerebrate animal. In the light of the entire plexus of phenomena of the epileptic seizure, however, still another cause must be considered.

It has been pointed out that the inhibition of the sensory apparatus proceeds in a regular order from neuron to neuron. As each neuron becomes disabled, the function of the neuron next in the continuation of the pathway becomes manifest. When the association pathways are finally extinguished, therefore, one must expect the functions of the efferent cerebral pathways to assert themselves. Too little is known of the normal function of the striatal pathway to be able to recognize its activity in the plexus of the epileptic manifestations. Somewhat more is known regarding the functions of the cerebrocerebellar and the cerebrospinal pathways.

Weed,[32] Cobb, Bailey and Holtz,[33] Warner and Olmstead,[34] Miller and Banting,[35] Löwenthal and Horsley[36] and others showed that

32. Weed, L. H.: Observations on Decerebrate Rigidity, J. Physiol. **48**:205, 1914.

33. Cobb, S.; Bailey, A. A., and Holtz, P. R.: Genesis and Inhibition of Extensor Rigidity, Am. J. Physiol. **44**:239, 1917.

34. Warner, W. P., and Olmsted, J. M. D.: The Influence of the Cerebrum and Cerebellum on Extensor Rigidity, Brain **46**:189, 1923.

35. Miller, F. R., and Banting, F. G.: Observations on Cerebellar Stimulations, Brain **45**:104, 1922.

36. Löwenthal, M., and Horsley, V.: On the Relation Between the Cerebellar and Other Centres with Especial Reference to the Action of Antagonistic Muscles, Proc. Roy. Soc. **61**:20, 1897.

stimulation of different portions of the cerebrocerebellar pathway (frontopontile, pontocerebellar, cerebellum) results in an abatement of decerebrate rigidity. Fröhlich and Sherrington [37] and others pointed to the spinocerebellar tracts as containing the afferent arms of the reflex arc which makes for muscular tonicity. The vestibular contingent of the cerebellum has been shown to have the same function. When, therefore, one sees that following the extinction of the entire sensory apparatus of the cerebrum the musculature becomes momentarily relaxed and, immediately after, contracted, one is justified in the following assumptions: (1) that the relaxation of the muscles is due to a manifestation of the function of the cerebrocerebellar pathway; (2) that, following this, the wave of the same disability having flooded the cerebrocerebellar pathway itself, the nerve mechanisms of posture of the lower neuraxis assert their function and the musculature is, therefore, thrown into a state of sustained rigidity.

The static seizures of brief duration described by Hunt [38] and by Menninger [39] are not improbably seizures which proceed no further than the stage of momentary muscular relaxation previously described.

The Stage of Convulsions.—Goodhart and Tilney [40] observed that the movements of dystonia and chorea represent certain concrete and well organized acts. In the present study of the epileptic movements the same holds true to a much greater degree. It must be borne in mind, however, that the normal posture of activity in the human being is the upright posture, and that the latter is impossible in the absence of the sensory state. The decerebrate cat or dog stands because, supported on four sides, its equilibrium is stable. The functionally decerebrate human being, however, falls because, no matter how strongly the joints are held together by tightly contracted antagonistic muscles, his equilibrium is unstable. Moreover, it is because the convulsive movements have never been observed, except in the prone position of the unconscious patient, that they have been from time out of mind considered as bearing no resemblance to any normal human activity—have indeed been looked on as repulsive, awe-inspiring, unearthly. A striking change takes place in the judgment of the observer when the picture of the convulsed epileptic person is turned so as to view the subject in the upright position. Outside of the occasional tremors and twitches,

37. Fröhlich, A., and Sherrington, C.: Path of Impulses for Inhibition Under Decerebrate Rigidity, J. Physiol. **28**:14, 1902.

38. Hunt, R. J.: On the Occurrence of Static Seizures in Epilepsy, J. Nerv. & Ment. Dis. **56**:351, 1922.

39. Menninger, K. A.: Static Seizures in Epilepsy, J. Nerv. & Ment. Dis. **59**: 54, 1924.

40. Goodhart, S. P., and Tilney, F.: Bradykinetic Analysis of Somatic Motor Disturbances, Neurol. Bull. **3**:295, 1921.

the movements are immediately recognized as consisting of a great variety of familiar acts, some of which are characterized by the qualities of beauty and grace. For the purpose of verifying the legitimacy of the assumption that the epileptic convulsion must be judged not from

Fig. 2.—Running athletes and a dancer. When the subjects are viewed as though they were in the prone position, their movements and postures appear to be as unnatural as those of the epileptic convulsion.

the prone, but from the upright position of the subject, I turned two photographs, one of running athletes (fig. 2) and the other of the movements of a well known dancer so as to view them in the prone position. The movements then appeared as unnatural as those of the epileptic convulsion.

A feature which distinguishes the movements of the epileptic convulsion from certain other abnormal movements is the following: Mention was made of the fact that choreic and dystonic movements are organized into certain concrete acts. Each such act in these diseases, however, is small, and the several small acts are repeated over and over again. The movements of hysteria are organized into grander acts, but

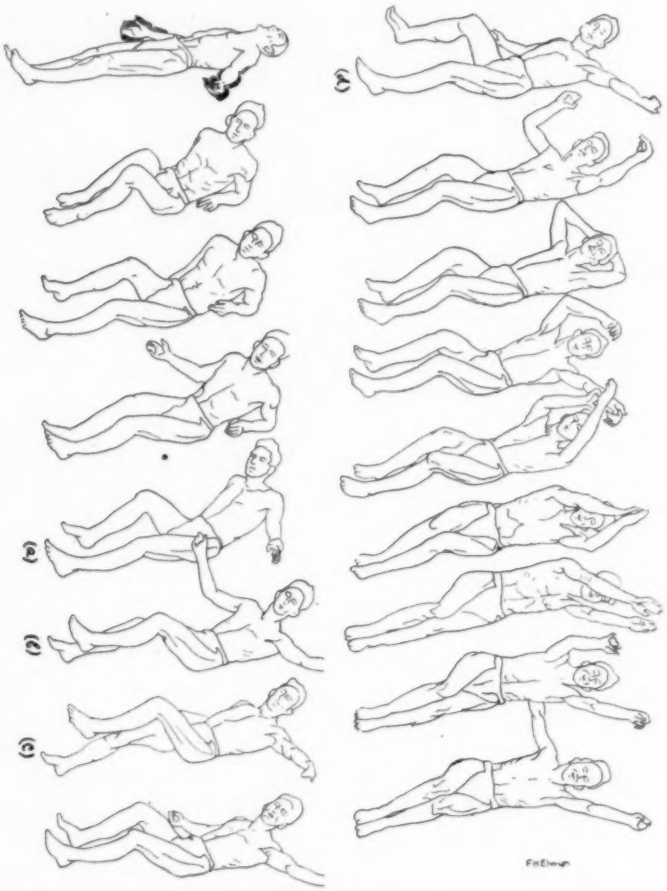

Fig. 3, I, II and III.—An epileptic followed by a "hysteroid" convulsion at II (*a*). Note the difference in the degree of muscular contractions in the two kinds of convulsion. Viewed as though the patient were in the upright posture, his movements of balancing on the toes of one foot at (*a*), (*b*), (*c*) and (*d*), I, are perfect.

these, too, are continually repeated. Of the seventy patients who submitted to the exercise of voluntary hyperpnea at the Craig Colony, the effect on a few was a hysterical instead of an epileptic seizure; another patient had a "hysteroid" convulsion during the stage of recovery from

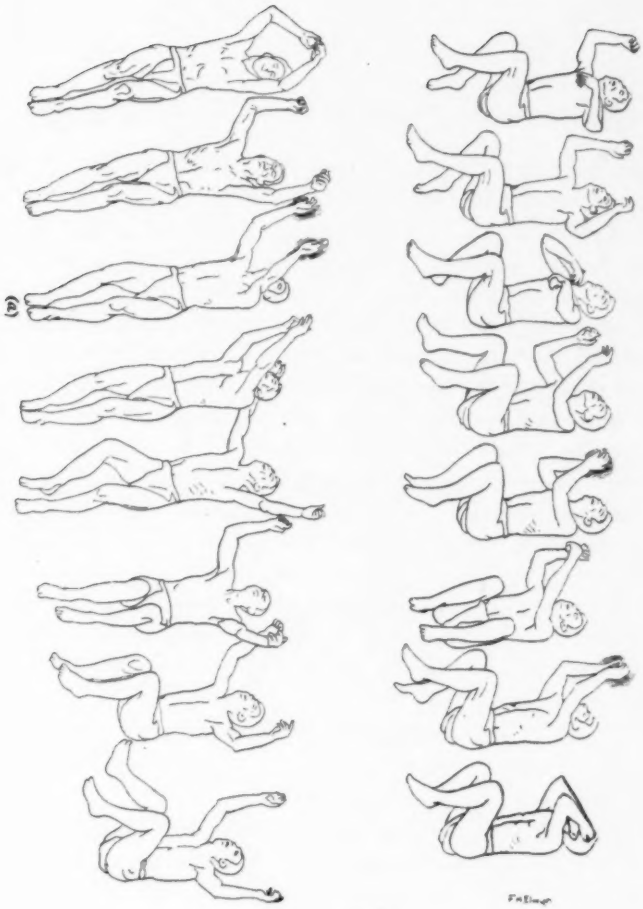

Figure 3—II

Figure 3—III

the epileptic seizure. In one patient the epileptic seizure merged into a prolonged hysterical stage. The pictures of the latter appear in figure 3, I, II and III. Figure 4 shows an hysterical attack from the beginning. Both patients during their performance wailed aloud for the Lord to save them. It will be seen that the acts performed are repeated over and over again. In the tetanic movements induced by overbreathing the same repetition may be observed (fig. 5). Throughout the pictures of the epileptic convulsion, however, few if any repetitions of acts can be found. Thus, where the act can be recognized as one of running, it may be seen to be diversified by turns of the head and body, with corresponding changes in the posture of the limbs, by leaps and bounds and plunges. It is as if the person were running along a winding road that is strewn with boulders and interrupted by hedges and ditches. A number of the convulsions are expressive of passionately emotional acts—acts of supplication worship, defiance, fulmination; others, of the execution of some special work. Others still represent stage-acting (fig. 6), posing (fig. 7), dancing (fig. 8) and balancing (fig. 3).

A study of the postures and movements of the epileptic patient reveals much significance regarding the nerve mechanisms of movement and posture of the conscious person.

It will be noted that the movements and the postures of the seizure are in large part such as are attained by the conscious person only by a process of training. An examination of figure 3, showing a posture of balancing on the ball of the great toe, of figure 9, in which the person appears to be rowing a boat, and of figure 8, showing the movements of a dancer, illustrate the point.

Since the decerebrate posture is known to be the habitual posture of the animal,[41] it occurred to me that the movements of the epileptic convulsion might be representative of similar acts of the epileptic patient in his conscious state. Careful questioning of a number of epileptic patients, with whose complicated coordinated acts during the seizure I was thoroughly acquainted, revealed the fact that they had never trained for any such acts. On trial, they indeed exhibited a total incapacity for their execution.

One may therefore conclude, with reason, that the particular organized patterns of muscular contractions which constitute each of the complicated coordinated acts of the epileptic seizure are inherent in the central nervous system.

That the movements of the epileptic during the convulsion are not such as he may have learned to execute during his conscious state, but

41. Richter, C. P., and Bartemeier, L. H.: Decerebrate Rigidity of the Sloth, Brain **49**:207, 1926.

Fig. 4.—A hysterical attack induced by overbreathing in an epileptic. The repetitions of the act should be noted.

that they are the manifestations of activated inherent patterns, may be judged from figure 10. This patient's left lower limb is amputated above the knee. Judged from his prone position, the movements have no meaning at all. Judged as though he were in the upright position, it will be readily seen that throughout the convulsion the movements are

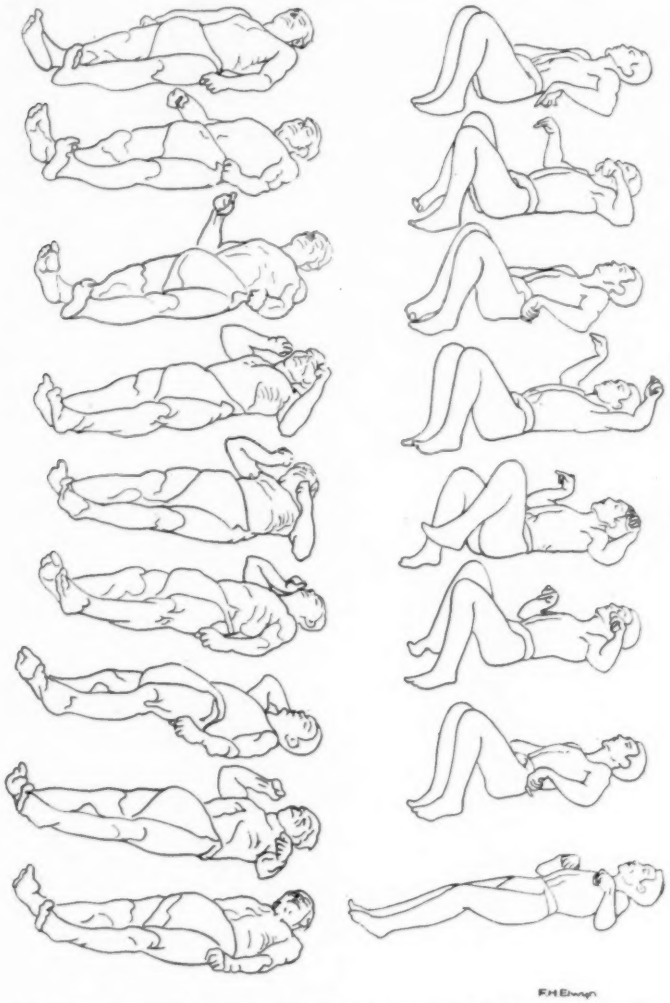

Fig. 5.—Tetanic movements (on the left) induced by hyperpnea. The patient is almost unconscious. On the right are tetanoid hysterical movements similarly induced. The movements of the latter patient are in synchrony with his respiratory movements.

suited to the posture of standing, not on one, but on two feet. So expressive of the latter fact are the postures shown that further comment would be superfluous.

The muscular contractions of the movements and the postures of the epileptic seizure are distinguished from those employed in similar acts by the conscious person in that the amount of energy employed in their production is by far too great. No matter how easy and graceful a

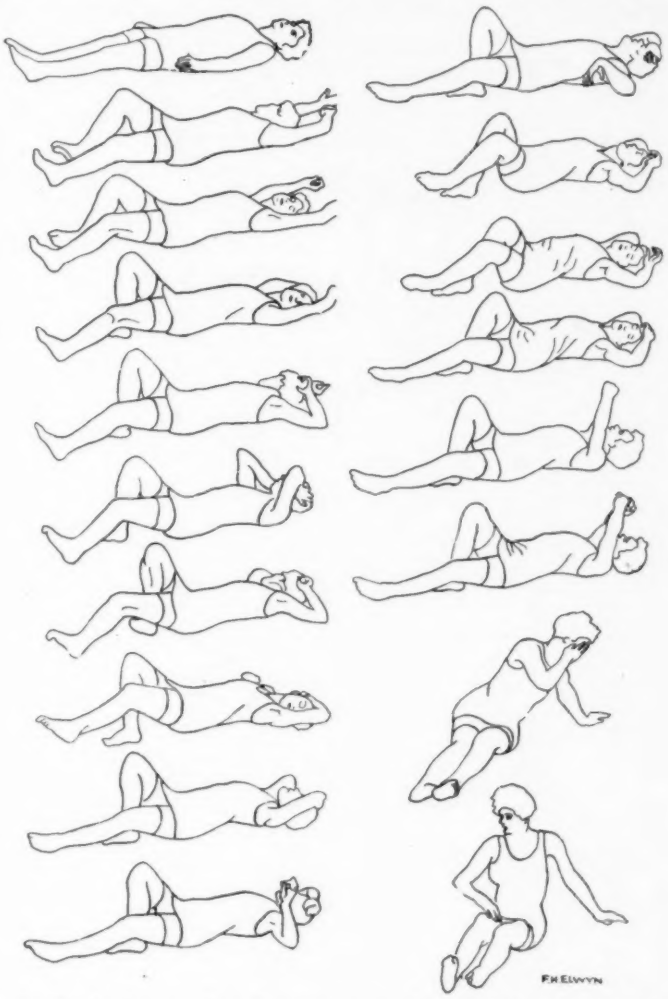

Fig. 6.—Perfectly coordinated movements of the head and the upper limbs. The facial expression of exaltation should be noted.

movement may appear in any act of the convulsion, the contraction of the musculature involved appears to be, in the totally unconscious epileptic patient, the greatest of which it is capable. In the so-called automatic movements of the epileptic patient in a minor attack, when any are present, the degree of strength of the contraction is much less.

And the same is true of the movements of hysteria. Such a relation of the sensory state to the degree of strength of the muscular contractions is indeed traceable with ease both in the various degrees of reduction of the sensory state in the epileptic and throughout a large number of other conditions. It may be seen in the accompanying illustrations of

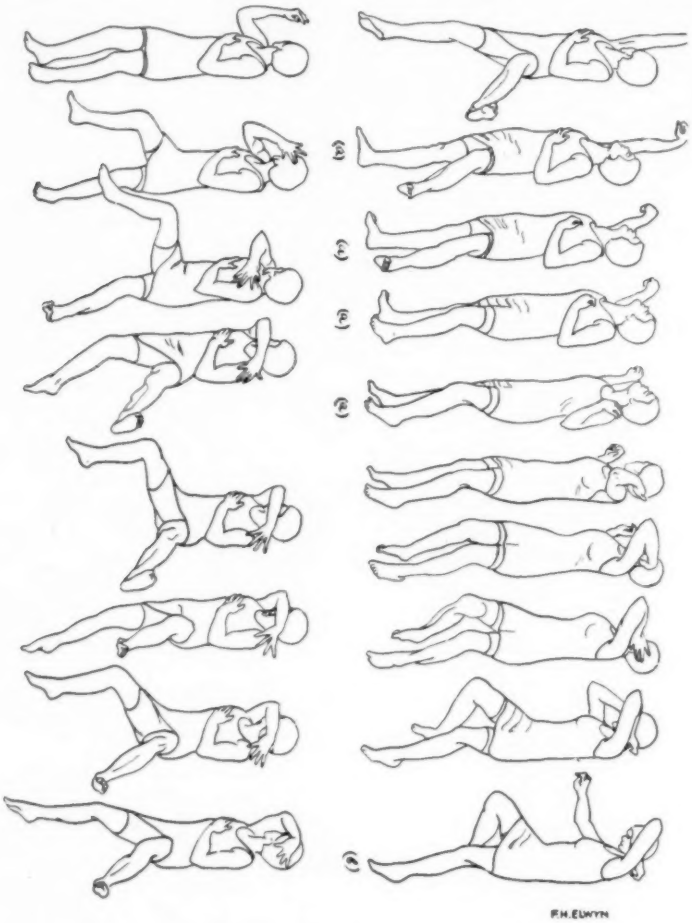

Fig. 7, I and II.—Remarkable posture at (*a*) and (*b*), I; and at (*a*), II. The posture at (*b*), II, reminds one of that of an orator.

the recovery from the epileptic seizure in fig. 3, I, II and III, figure 8, I and II, figure 11 and figure 12. There is therefore reason to conclude that the following statements are true:

1. The more profound and widespread the inhibition of the sensory system, the greater is the strength of the muscular contractions exercised in the production of any posture or movement.

2. The significance of training is the acquisition of a capacity for estimating the direction and the degree of the inhibition of the sensory system requisite for any particular muscular act. The direction must be estimated in order to activate the particular nerve patterns which represent particular muscular acts; the degree, in order to employ the

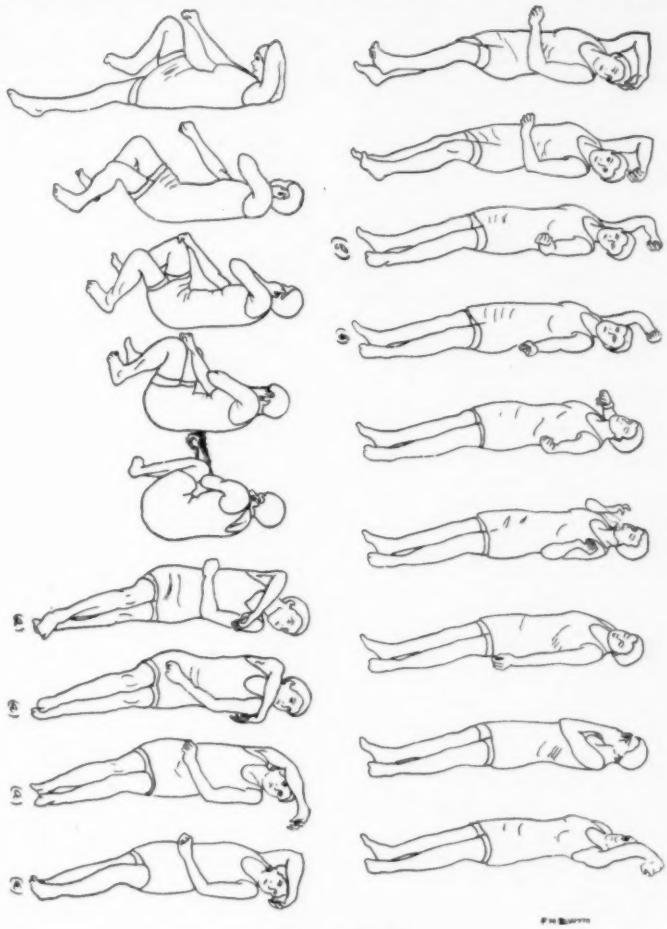

Figure 7—II

smallest amount of muscular strength compatible with the execution of the particular act. In this manner a wide margin of the sensory state is left open for purposes of orientation that enables the muscular act to be in correspondence with the person's surroundings.

The patterns of movement and of posture organized into acts are nearly, yet not quite, the same, in the successive seizures of the same epileptic patient. Observation of successive seizures reveals now and

then a diversification of an act previously observed by the introduction of such a movement as the rapid rotation of a hand in alternate directions, of the trembling of a foot, of the repeated opening and closing of the fingers and of other movements. In different epileptic patients the patterns of movement and of posture executed are very different. After observing a large number of seizures, one is struck by the fact

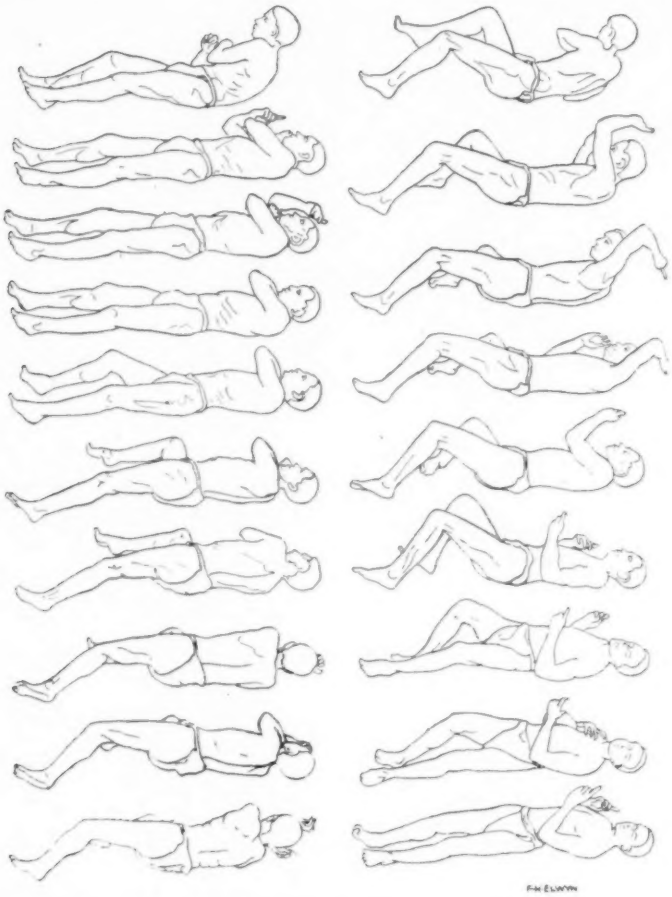

Fig. 8, I, II and III.—Dancing movements. Automatism is seen at (*a*), (*b*) and (*c*), III. The patient is making the sign of the cross.

that there is hardly a human movement or posture organized into a discernible separate act which is not reproduced in the convulsion. Even a study of the few seizures shown in the illustrations points to such a conclusion. If the acts of the seizure have their counterpart in inherent nerve patterns in the central nervous system, the following conclusions may be reached:

1. All posture-movement patterns which constitute discernibly separate acts have their corresponding nerve patterns inherent in the central nervous system.

2. The ultimate success or failure of a process of training in the execution of any act must depend on the presence or absence of cor-

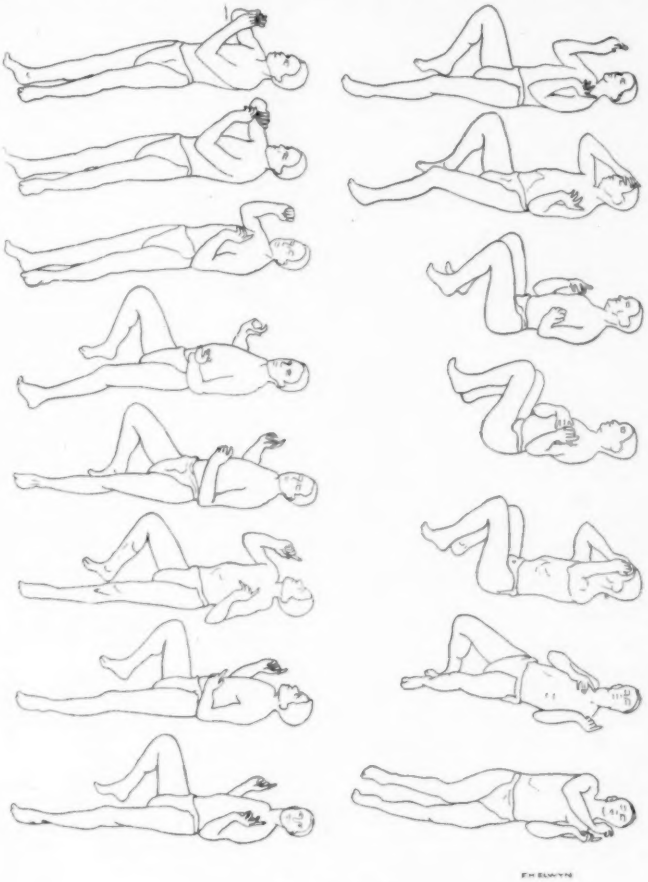

Figure 8—II

responding nerve patterns in the central nervous system of the particular person.

In the study of the red nucleus, Brown [42] found that stimulation of given points caused a change in the posture of the decerebrate animal. A change of posture signifies, of course, movement. Such movement,

42. Brown, G.: On the Effect of Artificial Stimulation of the Red Nucleus in the Anthropoid Ape, J. Physiol. **49**:185, 1915.

however, from one sustained posture to another, must be distinguished from the repeated changes of brief postures. The difference is relative rather than absolute. The prominent feature of the former is that once a group of muscles have, by their different degrees of contraction, adjusted their respective lengths to the given angle of a joint, their contraction becomes equal on all sides of that joint, thus maintaining the

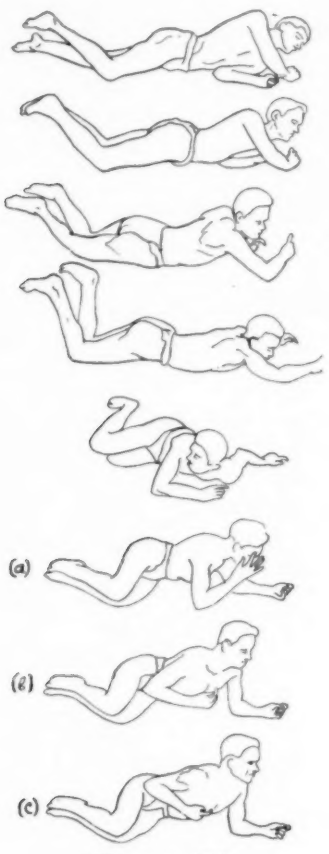

Figure 8—III

limb in the posture assumed. The prominent feature of the latter is the relative inequality of the muscular contraction on opposite sides of a joint, with the consequence that at any one moment the prevailing muscles, by their pull, continue changing the angle of the joint. Practically, it is fairly well established that the reflex arcs of the more widespread and complicated postures—postures entailing the simultaneous fixation of many joints—pass through the red nucleus and perhaps

through other cell groups at lower points in the brain stem. Many, if not most, of these reflex arcs must pass, therefore, by way of the cerebellum. Another fact which has been established, even more firmly than the preceding, is that the reflex arcs of the most widespread and complicated patterns of movement pass through the cerebrum; the

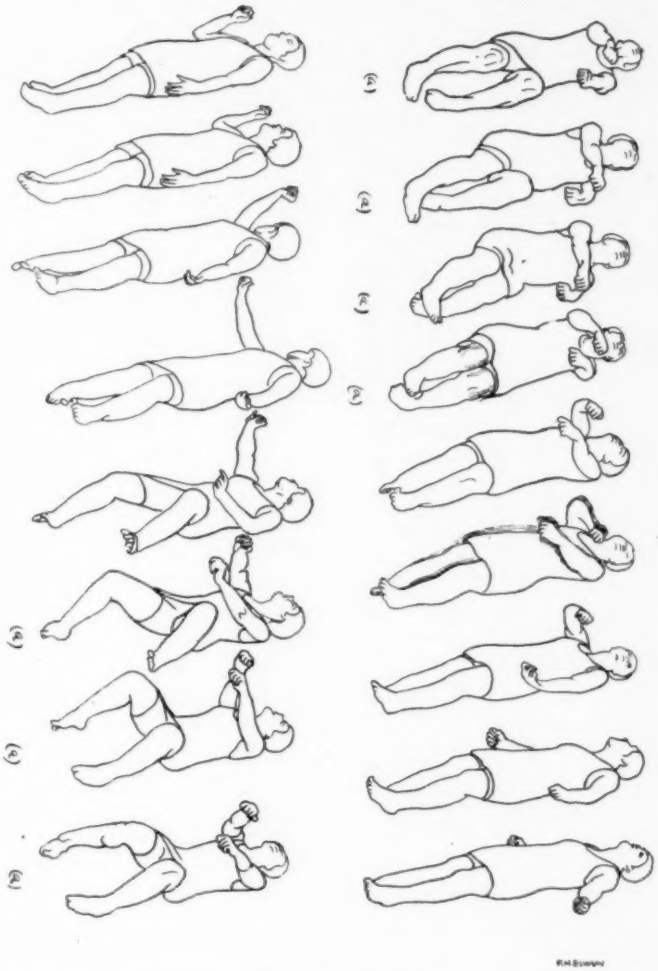

Fig. 9.—At (*a*) the postures are strongly suggestive of those of a person rowing a heavy boat.

afferent arms of those arcs consist of the sensory systems, while the efferent are the cerebrospinal tracts. There is a third set of long reflex arcs, apparently having to do with both posture and movement—the striatal system. The meager knowledge of its function, however, makes a gap in the argument inevitable.

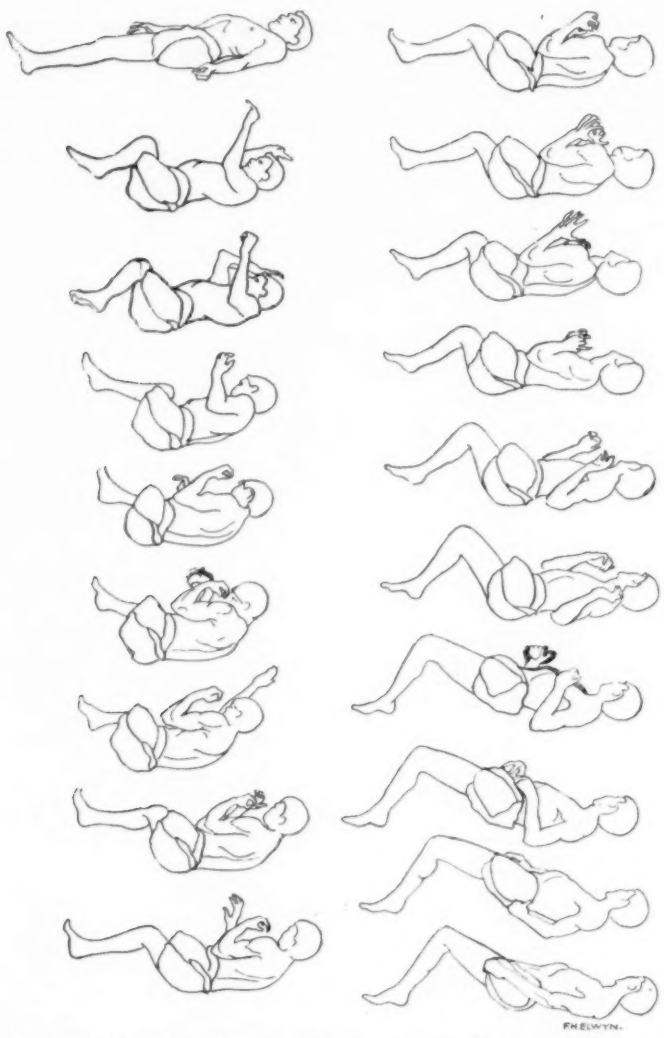

Fig. 10, I and II.—The pictures are illustrative of the fact that the movements of the epileptic convulsion are not such as the person may have learned to execute in his conscious state, but that they are manifestations of inherent nerve patterns. The patient's left lower limb is amputated above the knee. Judged as though he were in the upright position, his postures and movements are plainly seen to be suited to acts executed not on one but on two feet. His learned movements, on the other hand, may be seen when consciousness begins to return (II), in his efforts to adjust the bandage on his stump.

On the extinction of the entire sensory function in the epileptic seizure, one would expect all the efferent cerebral systems to become activated. As a matter of fact, however, not only does the activation of

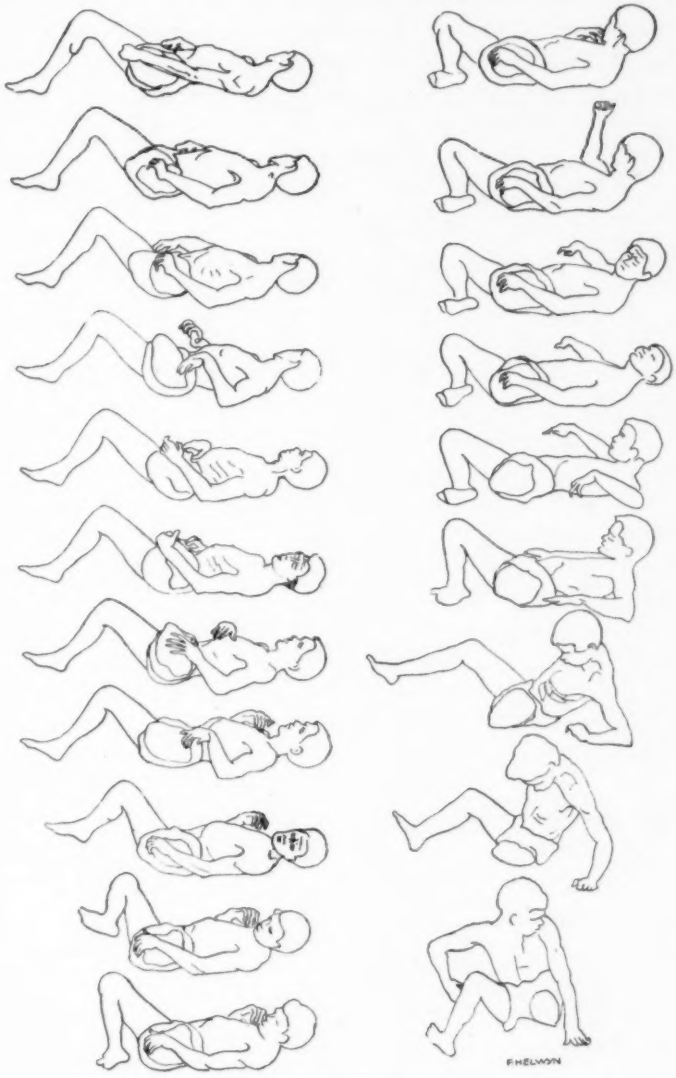

Figure 10—II

the palliocerebellar system precede that of the cerebrospinal, but it is, in its turn, disabled before the cerebrospinal system asserts its function. On consideration, however, it will be seen that such must also be the course of events in the conscious person. A movement of any part must be preceded by the fixation of joints—the establishment of posture—

of other parts; and the establishment of any posture for the purpose of a given movement must be preceded by the undoing of a previous posture. The undoing of a posture, however, implies a process of inhibition exercised on the mechanisms of posture; the activation of the mechanisms of the new posture implies, by the same token, the removal of the

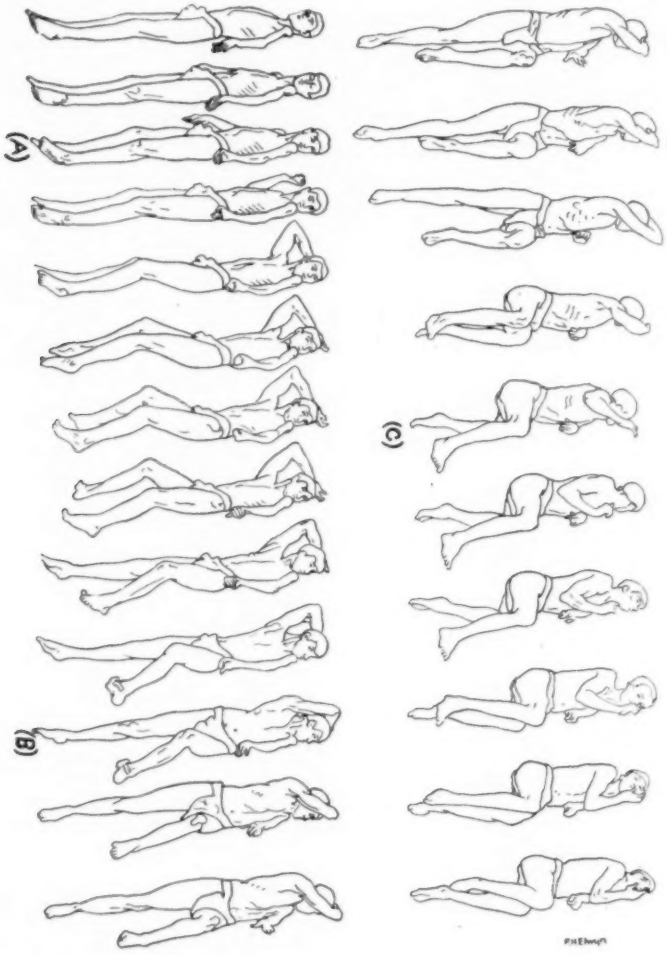

Fig. 11.—Atrophy of the muscles of the left shoulder and arm. A turning movement to the left. In the prone position of the patient the postures of the limbs are entirely unnecessary for the act of "turning over" on the left side. They are normal for such a movement in the upright position. In the anomalous prone position of the patient, the left lower limb, flexed at the knee, offers an obstacle to the turning movement. The act is accomplished by a complete change of the pattern at (*C*).

inhibition exercised over them. It is therefore only in the third place that the activation of the cerebrospinal system normally takes place. It will soon be seen that the subsequent phenomena of the epileptic seizure are fully corroborative of the argument.

On close observation of a number of epileptic seizures, it may be seen occasionally that muscles which have become contracted either in the production of posture or of movement are not completely decontracted in the subsequent postures or movements. The result in such cases is that contraction mounts on contraction until, at the height of the convulsion, muscles pull against tightly contracted antagonists. It appears as if an intense struggle were going on between the two nerve systems which, during convulsion, sway the field: the postural mechanism which tends to fix every joint; and the cerebrospinal, which by alternate additions of tonus to antagonistic muscle causes movement in spite of the former. A continuation of such a process must drain the energy of the body at a rate that must soon infringe on that necessary for the maintenance of the splanchnic functions, with death as the result. Fortunately for the epileptic person, the cerebrospinal and the postural nerve systems are now in their turn flooded by the same tide of inhibition which a while before brought about their activation. Before proceeding to observe the consequences of this event, however, a few more points in connection with the convulsion must be elucidated.

The Dominance of the Proprioceptive by the Cerebrospinal System.—The points to be mentioned in this section both need and deserve much more investigation than has been devoted to them in the present work. The few facts so far ascertained are suggestive of a special and fruitful line of research.

A factor to be taken into account in the study of the behavior of the animal decerebrated above the superior colliculi is the dual rôle of the sensory receptors. This duality is anatomically represented by the division of the afferent fibers, on their entry into the central nervous system, into ascending and descending branches. The ascending branches of the sensory nerves are for the greater part destined for the long reflex arc whose efferent side begins in the cerebrum. The descending branches constitute the afferents of a lower reflex arc. Thus, the sensory receptors are not entirely sensory, since the impulses which they transmit are in part destined for a nonsensory reflex arc. In animals decerebrated above the superior colliculi, the function of the sensory receptors is retained to the extent that they are able on excitation to propagate impulses along the lower reflex arcs. The Pollock-Davis preparations exhibit the latter fact in a striking manner. Pinching or the application of heat to a paw, or even clapping the hands in front of the suspended animal caused sudden repeated accessions of rigidity which appeared very much like the tonic fits observed in human beings

in injuries which sever the highest part of the midbrain. The ordinary laboratory demonstration of the defense movements of the decapitated frog, or the scratch reflex of Sherrington's spinal dogs, are illustrations of the nonsensory function of the sensory receptors.

Bearing these facts in mind, it must appear that the epileptic patient, during the convulsive stage of the seizure, is deprived of a much larger amount of nerve function than is the animal whose cerebrum had been removed by a section at the highest level of the midbrain. Not only is all purely sensory function wiped out, but even the reflex nonsensory function of the sensory receptors is suspended. Throughout a large number of observations I have never been able to modify the movements of the epileptic convulsion by an appeal to the sensory receptors. Changes in the pattern of the muscular contractions may, however, be brought about through the medium of the proprioceptive mechanism. Jonkhoff [43] has demonstrated the existence of the Magnus and de Kleijn tonic neck reflexes in an epileptic person. The operation of the same principle in a wider sense may be observed during the convulsion by restricting forcibly the movement of a limb. What then happens is a change in the pattern which accommodates the unrestricted parts to the posture of the restricted part so as to achieve the particular act in a different way. The experiment is ordinarily difficult to carry out and observe as to consequences, requiring as it does great strength on the part of the observer and a habit of sizing up quickly the correct value of a number of movements and postures organized into some definite act. Figure 11 illustrates the point. It shows a patient with atrophied muscles of the left shoulder and arm, as a result of infantile paralysis. The movement begins by a dominance of the musculature of the right side of the neck and the right shoulder, and the face of the patient is turned to the left (fig. 11, A). The strain produced by the twist of the neck and the muscles of the shoulder girdle to the left, in its turn, determines a spiral movement of the whole body around its long axis in the same direction. If the subsequent spiral rotation to the left is judged from the prone position of the patient, his posture—the raised right upper limb over the head, the flexed and abducted left lower limb and the rigidly extended right hip, knee and foot (fig. 11, B)—appears to be altogether unnecessary. In the prone position, indeed, a movement of "turning over" on the left side, is best accomplished by a thrust of the right upper and lower limbs directly outward and to the left. Judged as though the patient were in the upright position, however, his movements and postures are quite natural. A spiral rotation to the left around the long axis of the body is best accomplished by standing on the

43. Jonkhoff, D. J.: The Prognostic Importance of the Magnus DeKleijn Neck Reflexes in Man, Nederl. Tijdschr. v. Geneesk. **64**:307, 1920; abstr., J. Nerv. & Ment. Dis. **55**:519, 1922.

toes of one foot, in this case, the right. If any one will attempt to rotate to the left while standing on the right toes, he will discover that the left lower limb becomes automatically flexed and abducted, while the right arm is raised over the head, with the fingers pointing to the left. Were the patient actually in the upright position, there would be no further change of pattern until the movement was completed. The patient is, however, in the anomalous prone position, in postures which are suited only to an upright one. The consequence is that the flexed left lower limb impinges with the knee on the ground and creates an obstacle to the further rotation of the body to the left. The greater the force of the rotation of the upper part of the body, the more serious becomes the obstacle of the protruded left knee. The stretching of the abductors of the left thigh then brings about a breach in the existing pattern, and a new pattern is created which makes the achievement of the act possible under the circumstances. The right thigh and foot begin to flex, and the right foot is thrust forward until that knee and foot are in advance of the left; the right forearm is thrust in the same direction (fig. 11, C). This shifts the weight of the body and makes it possible for the person to remain in a stable position on the left side.

It would therefore seem that, of the two nerve mechanisms which sway the field during the convulsion, the function of one is to bring about certain concrete acts, such as the act of turning the body in the foregoing illustration; the function of the other is to enable the achievement of that act by any means. The manner in which the latter mechanism is enabled to carry out the details of the muscular coordination that are entailed in the achievement of any concrete muscular act has been shown by Sherrington, by Magnus and de Kleijn and a number of other investigators. But the manner in which the cerebrospinal system subordinates the proprioceptive mechanism of muscular coordination is not known. Its discovery is the task of the future.

Convulsions and Hemiplegia.—Pike and Elsberg's [44] experiments show that in cats convulsive movements may take place after the injection of absinth even though the motor area of the cortex had been removed. After a study of fifty-seven patients with gunshot wounds of the skull, Redlich [45] concluded that when the motor area has been too extensively injured it cannot longer be a factor in the production of convulsive movements. Nearly fifty years ago, Oebeke [46] described two cases of hemiplegia with convulsions. One was that of a patient who sustained a hemiplegia of the right side at the age of 17. Two years

44. Pike, F. H., and Elsberg, C. A.: Studies in Epilepsy, Am. J. Physiol. **72:** 337, 1925.

45. Redlich, E.: Zur Pathologie der Epilepsie, Ztschr. f. d. ges. Neurol. u. Psychiat. **48:**8, 1919.

46. Oebeke: Berl. klin. Wchnschr. **17:**534, 1880.

later this patient became afflicted with epilepsy. The convulsion would begin on the paretic side and then spread to the sound side. The other patient had been subject to generalized epileptic convulsions from birth. In adult life he suffered a stroke of hemiplegia of the left side. The convulsions since then affected the right side only. A number of other facts distributed throughout the literature on epilepsy exhibit like discrepancies. The convulsive episodes in human beings generally appear at a time when the observer is not prepared for observation. Under such circumstances it is difficult to detect and to record a number of small movements and postures, which at times take place with surprising rapidity. The movements in small animals are even more rapid than in man. During the brief period of the convulsion, slight changes of posture of the limbs which are not prominently convulsed are almost impossible to detect, particularly when the body of the animal is necessarily made free for the purpose of observation. The convulsive movement of one limb, imparting a movement to the body of the animal, tends either to disguise or to simulate a movement or change of posture of another limb.

Four of the patients at the Craig Colony, in whom seizures were induced, were affected with residual hemiplegia, two on the right and two on the left side. The symptoms of those patients were the classic residual disabilities of a hemiplegia sustained in early life: the amount of function remaining was greater in the lower than in the upper limbs; they walked with a slight limp; the disabled upper limb was held in a slightly flexed posture; the tendon reflexes were increased in the affected limbs, and the great toe on the affected side showed the usual abnormal response to plantar stimulation.

The pictures of the convulsion of these patients appear in figures 12, 13, 14 and 15. It will be seen that the two right hemiplegics (figs. 12 and 13) exhibit during the convulsion an accentuation of the hemiplegic posture of the upper limb, which is sustained nearly throughout. The posture of the upper limb of the left hemiplegic (fig. 14) is accentuated and sustained in the later part of the convulsion. During the first part of the convulsion, however, the affected upper limb is extended. The picture of the other left hemiplegic (fig. 15) exhibits a complete lack of paralysis during the convulsion. As a matter of fact, that limb may be seen to execute a number of complicated movements, such as the opening and closing of the fingers, rotation of the hand in alternate directions, a movement of the hand to and fro, etc. As soon as consciousness begins to return, the helplessness of that limb becomes evident (a).

In three of the four pictures of the hemiplegics, the disability of the lower limb is seen to disappear completely during the convulsion. In the

fourth (fig. 15) the posture of the paretic lower limb is accentuated and sustained during the convulsion.

In the absence of information regarding the precise extent of the pyramidal injury in these patients it is impossible to account completely for such discrepancies. It is perhaps reasonable to assume that certain portions of the pyramidal tract are affected to different degrees in different patients.

A better explanation of the particular form of the convulsion of the hemiplegic epileptic patient can be discovered from a consideration of the mechanism of the partial recovery of function after hemiplegia, to be taken up presently.

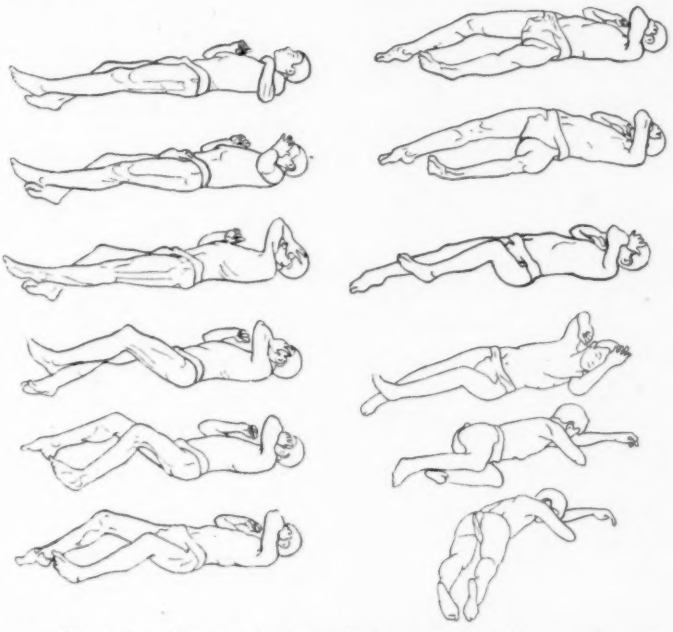

Fig. 12.—Right hemiplegia; the hemiplegic posture of the paretic upper limb is accentuated throughout; that of the lower, toward the end of the convulsion.

Recovery from Hemiplegia and the Epileptic Convulsion.—Ogden and Franz [47] and others [48] have demonstrated the decided benefits of early and persistent training in hemiplegia. Von Monakow [49] related that he had seen the entire pyramidal area of the cortex thoroughly

47. Ogden, R., and Franz, S. J.: On Cerebral Motor Control, Pyschobiol. **1**:33, 1917-1918.

48. Franz, S. J.; Scheetz, M. E., and Wilson, A. A.: The Possibility of Recovery of Motor Function in Long-Standing Hemiplegia, J. A. M. A. **65**:2150, (Dec. 18) 1915.

49. Von Monakow, C.: Die Localisation im Grosshirn, 1914, p. 183.

destroyed in patients who, notwithstanding, retained a considerable degree of function. Since Hughlings Jackson called attention to its significance, every physician has become familiar with the fact that in hemiplegia the more distal joints, especially those of the hand and fin-

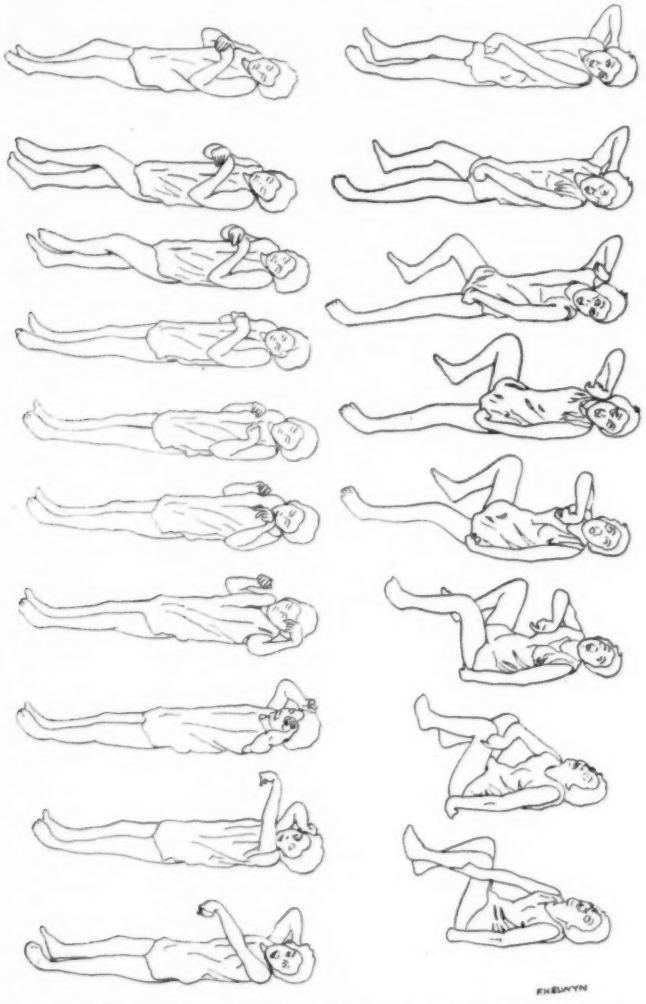

Fig. 13. I and II.—Right hemiplegia; the paretic posture of the upper limb is accentuated during the greater part of the convulsion; that of the lower, during the first part.

gers, suffer most; the more central, relatively less. These facts correlated with certain other facts, dealt with in an earlier section of this paper, enable one to understand the partial recovery of function in hemiplegia.

The fact was mentioned that in the performance of timed and measured movement at any relatively distal joint, the relatively central joints must be fixed in posture, and that any new movement involves a change of posture. Although a change of posture is distinguishable by certain characteristics from movement proper, nevertheless it is a movement. It will be noted that the parts which recover most in hemiplegia

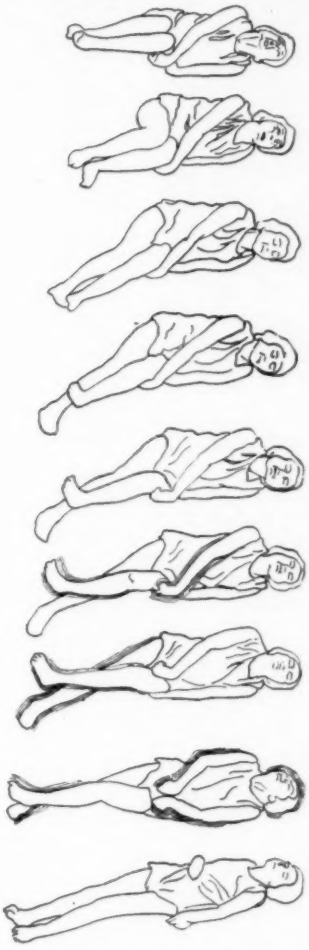

Figure 13—II

are precisely the relatively central joints—those which are most often employed in the acts of posture and of change of posture. The latter functions belong not to the pyramidal tract, but to the red nucleus,[50] the cerebellum and certainly also to the corpus striatum.

50. Rademaker, G. G. J.: The Significance of the Red Nuclei, abstr., Brain **47**:390, 1924. Brown (footnote 42).

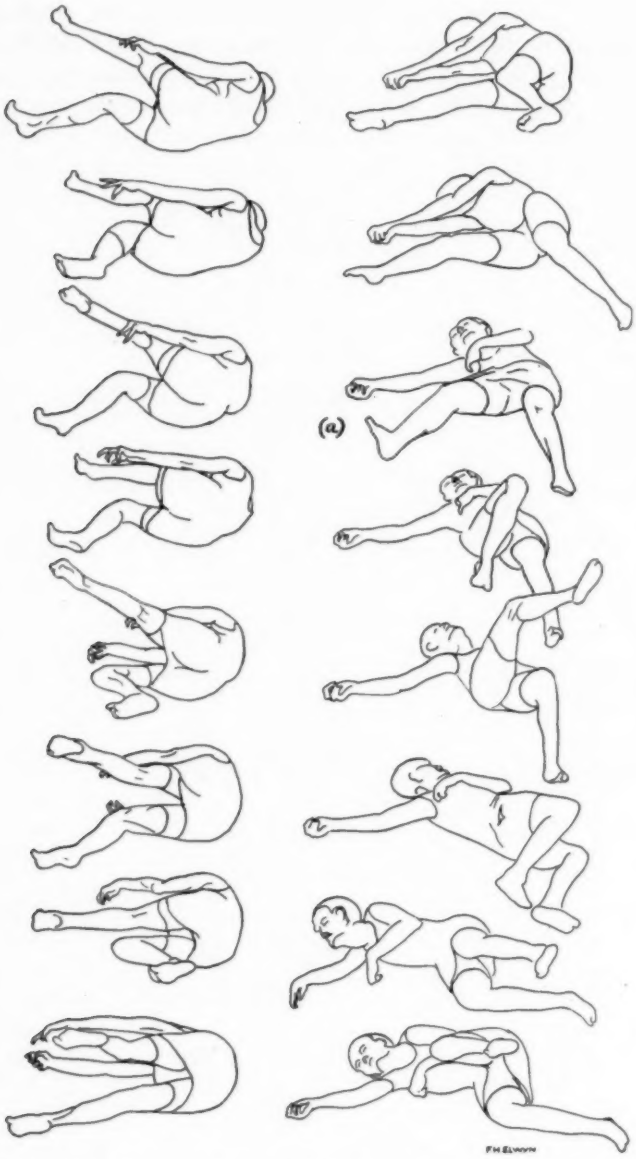

Fig. 14, I, II and III.—Left hemiplegia. A very active convulsion. The accentuation of the posture of the upper paretic limb begins at (*a*), I, and is maintained throughout II. The paretic lower limb manifests no disability in any part of the convulsion.

The recovery of function after hemiplegia is, therefore, not so much in the sphere of movement proper as in that of changes of posture. And this function, like any other function, is susceptible to training under certain conditions. One of these conditions has been shown to be the existence of the particular posture patterns in the nervous system

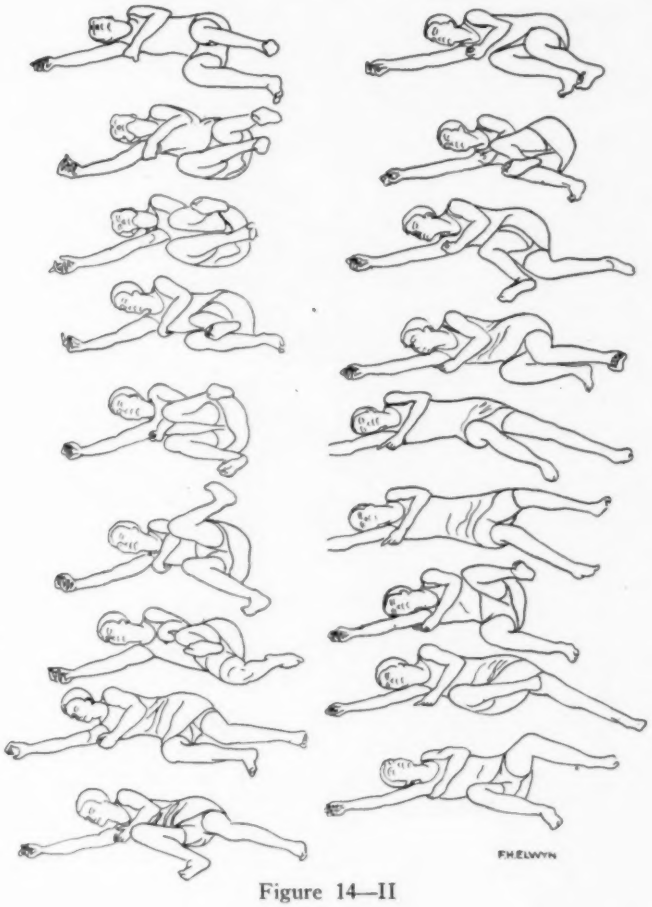

Figure 14—II

of the particular person. It is only reasonable to assume that the facility for changes of posture is naturally greater in some persons than in others. In the convulsions of different hemiplegic epileptic patients, therefore, even though the extent of the pyramidal injury is equal, one must be prepared to find differences in the facility of the posture changes which simulate the function of the pyramidal tract and which largely substitute for the latter when it is absent.

The Muscular Manifestations of Normal Thought: An Erroneous Psychology.—The muscular activity which is generally associated with states of attention is of two kinds. The function of one is to bring the sensory organs into a position which is most advantageous for the reception or the avoidance of a stimulus. The other consists in automatic—purposeless—movements and postures, or in planned—purposeful—movements and postures.

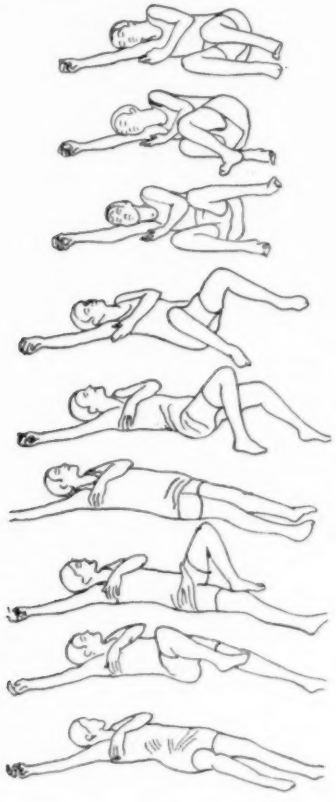

Figure 14—III

That such muscular activity is generally, but by no means necessarily, associated with the sensory process of thought must be clear from the following considerations: The muscular activity whose function is to place the nerve receptors in an advantageous position for the reception of the stimulus is, from the nature of the case, called into play only when the position of the receptors is unfavorable for its reception. It must be borne in mind that any movement of the organism is only with relation to its surroundings. A visual stimulus which

impinges at an acute angle on the retina may necessitate a movement of the eyeball that will bring the retina into a plane perpendicular to the direction of the light. But if the visual stimulus has itself moved into the field of clearest vision, there is no occasion for the movement of the eyeball. And the same is true even to a greater extent of the expe-

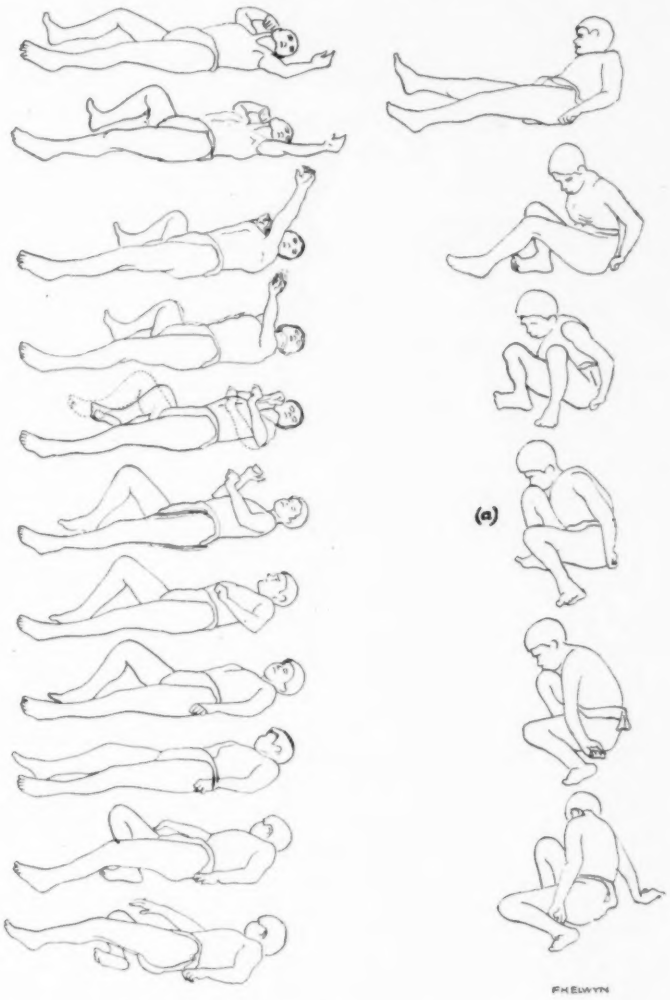

Fig. 15, I and II.—Left hemiplegia. The paretic upper limb executes a number of complicated movements in the first part of the convulsion. The first glimmer of returning consciousness manifests the helplessness of that limb, beginning at (*a*), I, and that helplessness becomes very obvious in the patient's attempt to rise at II. The paretic posture of the lower limb is accentuated throughout the convulsion.

riences of touch in the skin of a limb which is thoroughly supported and relaxed, when it is the touching object which moves toward the limbs to be touched. The principle involved is most familiar in its broadest application: that the movements of the organism for the purpose of replenishing its stock of energy are less in proportion as that

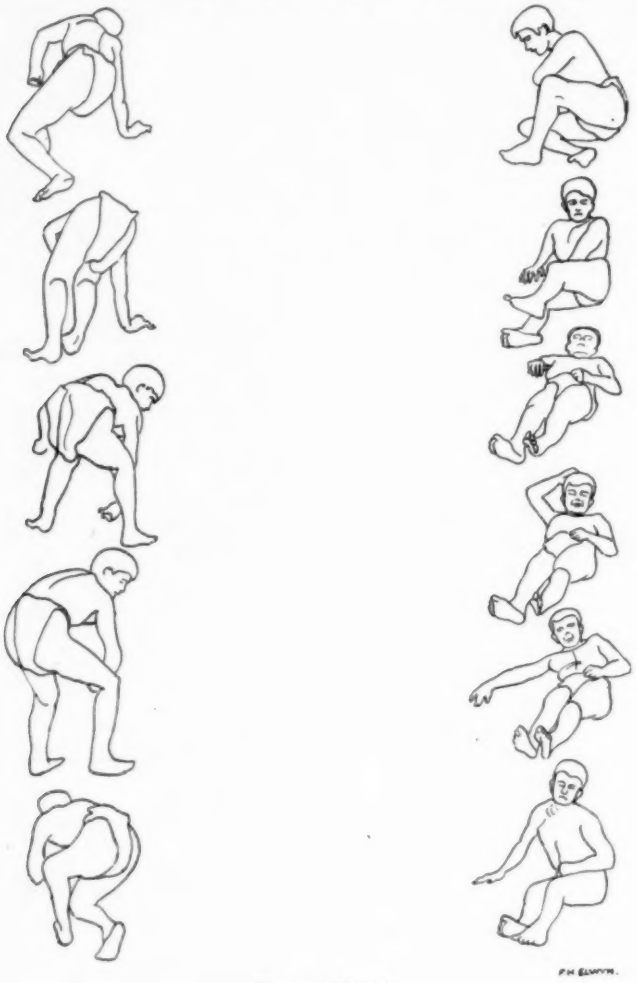

Figure 15—II

stock is moved toward the organism. Mahomet goes to the mountain only because the mountain will not come to Mahomet.

If the foregoing is true, then the belief held by a certain school of psychology that thought is synonymous with muscular activity cannot be true. That belief is largely based on the philosophic impossibility of establishing any line of demarcation between movement and no move-

ment. With relation to muscular activity the conundrum is expressed in the terms of explicit and implicit muscular action. It will be seen from the preceding, however, that the explicit movement of a needed object toward the organism, far from implying any muscular activity on the part of the organism, excludes any necessity for it.

Moreover, it has been seen that the state of attention consists in the activity of only a part of the sensory system at any one time; and that, at the same time, another part of that system is inhibited. If the inhibition of a part of the sensory system extends as far as certain parts of the efferent systems, then one is prepared to see the manifestation of function of those parts, in the same manner as one saw it in the epileptic convulsion. The person absorbed in thought may indeed exhibit an automatic muscular activity. Aimless wandering, a swaying of the body to and fro or from side to side, kneading of the hands and face, are the familar movements of the thinking person. Such movements may be observed also in the epileptic seizure. If, however, the inhibition of a certain contingent of the sensory system in the process of thought extends only as far as the cerebral association systems, then their function must be manifested without any activity of the efferent cerebral system. Furthermore, if the inhibition recedes at this stage, thought remains a purely sensory phenomenon—an impression made on the sensory pathways that will modify future sensory impulses and so perhaps bring about a future modification of a corresponding muscular reaction.

Nor is the purposeful muscular activity subsequent to processes of planning of an essentially different character from the automatic movements during the process of thought. The fact that the most important human muscular activity is subsequent to the sensory processes of study and thought is indicative of the procession of a wave of inhibition along the sensory pathway either as far as the association systems only, or further—as far as the efferent pathways of the cerebrum. For this is the order of events: first study, then thought, then—perhaps—action. Important activities begin only after a decision to act, and the latter implies a corollary decision to cease studying and thinking—to inhibit largely the activity of the sensory system.

A number of pathologic conditions might be cited against the hypothesis that thought is synonymous with muscular activity. A single example must suffice. That even the severance of so important an efferent system as the cerebrospinal tract, with the consequent paralysis, does not interfere with the sensory function of thought is exemplified by Pasteur's career. It will be remembered that this great Frenchman launched on his monumental work after having sustained a hemiplegia.

THE WANE AND THE EXTINCTION OF THE EFFERENT SYSTEMS

The Stage of Dorsiflexion of the Great Toe.—The appearance of the sign of Babinski after the cessation of the convulsive movements

was described by Collier [51] nearly thirty years ago, and later by Jellinek.[52] In my own experience it was present in about 75 per cent of the cases. Its duration is determined by two factors. It is longer following a more severe convulsion, and it is cut short by the onset of the next stage of muscular flaccidity. On the whole, its duration is from a few seconds to a few minutes. After a period of frequently repeated convulsions, however, the sign may persist for a number of hours.

In the light of what was said regarding the march of inhibition along the sensory nerve pathway, the appearance of the sign of Babinski at this stage is the logical sequence of the course of events. If, by the extinction of the neurons preceding the pyramidal tract, the function of the latter becomes manifest, then a further procession of the inhibitory wave must flood and disable the pyramidal tract itself, with the signs of its disability as a result.

The Stage of Muscular Flaccidity.—After the disappearance of the abnormal reflex of the great toe, the person's musculature becomes flaccid. A limb raised by an observer and allowed to fall, drops like a flail.

The tide of inhibition at this stage appears, therefore, to have reached the muscular end of the reflex arc.

THE RECESSION OF THE WAVE OF INHIBITION

Recovery.—If the theory of a regular procession of an inhibitory wave as the immediate cause of the several symptoms of the epileptic seizure is true, it might be expected that the recession of the wave in the process of recovery would be marked by the same symptoms as the preceding, only in the reverse order. It must, however, be remembered that the neuromuscular system of the patient has exerted in the seizure the utmost activity of which it is capable—has released nearly the entire stock of energy outside of that small reserve without which the automatic vegetative functions must cease. The neuromuscular manifestations of the recession of the tide of inhibition are, therefore, expected to be weak, and the entire plexus of these manifestations distorted. Weak and distorted as these may be, however, they are readily recognized as of the same kind and as succeeding each other in the reverse order in which they appeared. The tendon reflexes gradually return. Then follow involuntary movements which are either of the nature of automatism or of a convulsion known as "hysteroid." Both of these are shown in the illustrations (fig. 8, 3 and 10). In this stage the patient is largely insensible. In taking the moving pictures, a number of the

51. Collier, J.: An Investigation upon the Plantar Reflex, Brain **22**:71, 1899.

52. Jellinek, S.: Spasmsymptome des epileptischen Anfalles als diagnostische Kriterien, Wien. med. Wchnschr. **69**:2195, 1919.

patients in this stage gazed directly at the open arc light, appeared to be fascinated by it, and some attempted to reach out for it or to walk into it. Their weakness, however, was so great that they were restrained with ease. The extent of the muscular exhaustion may be observed in some of the pictures in which the patients are seen to make unsuccessful attempts to rise (fig. 15, II). Next follows a rather prolonged period during which the patient is dazed. In a number of instances, however, the patient emerges from the cloudy state of mentality rapidly. Two of the patients studied at the Craig Colony arose almost immediately after the convulsion, made the sign of the cross, thanked me and went about their business.

THE SIGNIFICANCE OF THE MECHANISM OF "RELEASE"

The Converse Implication of the "Release" Phenomenon.—It has been seen that the mechanism of "release" is operative throughout in the production of different sensory states and of muscular activity. The phenomenon consists of the activation of a "length" of nerve pathway on condition that a preceding "length" of the same pathway is inhibited, or, as is the case in certain diseases, actually severed. Whether such a "length" of the pathway amounts to a single neuron or to more than one neuron it is impossible to say on account of ignorance regarding the numerous collaterals and the intercalated short neurons in the central nervous system—the gaps in knowledge to which Oliver Strong [53] recently called attention. Ignorance of the details of the mechanism, however, does not invalidate the general proposition.

A glance at the converse of the phenomenon of "release" is of assistance in explaining a number of puzzling problems.

One such problem is the existence of seemingly purely inhibitory pathways. The palliocerebellar pathway has been shown to exercise an inhibitory influence by an abatement of decerebrate muscular rigidity.[54]

The function of the palliocerebellar pathway has been shown in the appearance of the momentary relaxation in a certain stage of the epileptic seizure. Such a constantly inhibitory action of a nerve pathway lends itself, in the light of the facts with which I have dealt, to a simple explanation. If a degree of inactivity of a certain stretch of a nerve pathway results in a corresponding degree of activity of the next stretch of that pathway, then the converse of this phenomenon must likewise be true—the activity of any part of a pathway must result in a corresponding degree of inactivity of the next part. The activation of the

53. Strong, O. S.: Unsolved Problems Suggested by Cerebellar Connections and Cerebellar Histology, Arch. Neurol. & Psychiat. **19**:1 (Jan.) 1928.

54. Weed (footnote 32). Cobb, Bailey and Holtz (footnote 33). Warner and Olmsted (footnote 34). Miller and Banting (footnote 35). Löwenthal and Horsley (footnote 36). Fröhlich and Sherrington (footnote 37).

cerebrocerebellar pathway, therefore, must result in a diminution of activity of the lower reflex arcs of the cerebellum on which it plays. The result is an undoing of posture by the abatement of tonus.

A fact which has never been explained is the unresponsiveness of the cerebral cortex to electrical stimulation, except for the pyramidal area. The postcentral convolution is directly connected with the precentral convolution by countless thousands of "short" fibers. Yet the application of an exciting current to the postcentral convolution has no effect in activating the pyramidal tract. The converse of the phenomenon of "release" offers an explanation. In accordance with the facts heretofore observed, the activation of the pathway which precedes the pyramidal tract not only should not cause any activity of that tract, but should, if anything, result in its inhibition.

A large number of psychologic phenomena can be explained on the same basis. The following are examples:

It is a familiar fact that a volitional effort to bring about or to enhance certain reflex activities results in exactly the opposite effect. Thus, a volitional effort to sneeze effectually prevents the act of sneezing.[55] The volitional effort on the part of a novice to appear at ease at a social function results in an awkwardness of behavior which is popularly styled self-consciousness. Volitional effort consists in the activity of the cerebral association systems. Such activity, instead of releasing the function of the efferent systems, inhibits it.

Popular psychology has it that the self-conscious person is laboring under too many inhibitions, and that the traditional efficacy of the glass of whisky in such cases is due to some action of the alcohol in removing the inhibitions. Exactly the opposite is true. The action of alcohol is to inhibit the highest functions of the cerebrum—that of the association systems. The latter being inhibited, the function of the efferent systems is released and activated, and the movements of the person, therefore, are then marked by greater freedom. The self-conscious person, therefore, is too free from inhibition—he hears too much and sees too much of what is going on about him—he is too much oriented.

The Biologic Significance of "Release."—In the doll which moves as its different parts are pulled by strings, in the baby-carriage which moves as it is pushed—in any contrivance which is operated from moment to moment by the current of an outside force—there is no place for the mechanism of "release." Machines of this kind are not dependable for continuous operation; the cessation of the outside force results in a like cessation of their movements. The animal machine must operate continuously, or it is destroyed. Its motive power is, therefore, derived from a store of energy of its own which, as it is expended, is periodi-

55. Darwin, C.: Expressions of the Emotions in Man and Animals, New York, D. Appleton & Company, 1873, p. 37.

cally replenished from the outside. Moreover, the energy liberated by the operation of the animal machine is derived but indirectly from its general store, each special tissue having a special store of its own, whose stock is periodically replenished from the general store of the body energy. Thus will a muscle or a nerve proceed to function for a time on its own special stock of energy; it is, therefore, for a time, self-sufficient.

When nerve conduction takes place as the result of the application of some disturbance to a nerve, the process must not be conceived as a conduction of the disturbance, but as a reaction of the nerve to the disturbance by the liberation of a certain amount of the energy which it contains. The action of a stimulus is, therefore, literally, to release a certain amount of energy contained in the nerve and in the muscle.

The Shortcomings of the Theory of "Release."—What is one to think when one finds that a manifestation of function takes place in a neuron in consequence of the inhibition of function in another neuron which precedes the first in the line of conduction? Regarding the disturbance which is necessary in order to release the energy of a neuron, one may legitimately speculate that within the living body one need not seek for it far. The movement of the fluid about the neuron or the presence of certain substances in that fluid may not impossibly be a source of such a disturbance. The question is, Why is not the same disturbance adequate to cause the same result in a neuron when another neuron immediately preceding it is not inhibited or disabled in other ways? It is a question that cannot be answered in the present state of knowledge of the nature of nerve conduction. Nor does one understand why such a release of energy occurs in certain conditions and not in others—why, for instance, visual hallucinations take place in certain injuries of the optic pathways and why hallucinations of other sensations do not take place in tabes dorsalis, in the Brown-Séquard syndrome and in other diseases. That the manifestations of life in every known phase are brought about by a release of the energy stored within the living tissues, and not by any direct pull or push of the forces on the outside, is certain. The details of the mechanism, however, are still unknown.

THE EPILEPTIC HABIT

The Rhythm of Epilepsy.—If the epileptic seizure—no matter what the causative disease—is an exaggerated form of the normal process by which the reduction of the sensory state results in muscular activity, then the periods of its recurrence must be subject to the same general conditions to which those of other functions are subject. Fundamentally, the periodicity of function is, of course, traceable to the rhythm of motion. Practically, the rate of recurrence of certain functions is

dependent on that of others in the body. Thus, the rate of the heart beat bears a certain ratio to that of the respiratory activity, and both these functions depend for the rate of their recurrence on the rate at which energy is liberated from the body. The rate of recurrence of functions such as feeding, although in the long run depending on the amount of energy liberated, is largely a matter of individual habit and social convention. Considered as a mental and muscular function, the epileptic seizure must depend for its recurrence on several factors. One of these consists of the periods of increased instability of the nervous, muscular and glandular tissues which recur with more or less regularity in all persons. The menstrual period favors the occurrence of the seizure. Since the major seizure results in a large liberation of energy, the rate of its recurrence must, among other things, depend on the capacity of the particular person for storing and liberating it. The efficacy of starvation diets in diminishing the frequency and severity of the seizures, and the immediately diminished susceptibility following a seizure, are not improbably due to this fact. Other things being equal, the recurrence of the seizures, like most mental and muscular functions, becomes firmly established by habit. In this respect, the penetrating Gowers [6] ascribed to habit a place of honor at the board only next to the first seizure itself.

The Efficacy of Neuromuscular Discipline in Epilepsy.—Like all mental and musclar habits, the epileptic seizure is susceptible to modification by training. Mention has been made in the first chapter of the fact that epilepsy is a form of the tetanic state. In the tetany induced by hyperpnea the two prominent symptoms are a reduction of the sensory state and a consequently heightened muscular activity in posture and in movement. Like epilepsy, therefore, the tetanic state itself consists in an increased facility of the process of inhibition. In his electromyographic studies of experimental convulsions, Cobb [56] found no difference between the action current of muscles contracted in the postures (tonic spasms) of convulsion or in that of a normal reflex—both were of the tetanic kind. Nor did he find any difference between the action currents of muscles engaged in the alternate contractions of the convulsion (clonic spasms) and those similarly engaged in normal reflex movements. The differences between normal, convulsive and tetanic muscular contractions are, essentially, only with respect to their timing and their distribution. I have shown, however, that the timing and distribution of movements and postures which occur in consequence of the neural activity of the cerebral efferent pathways are subject to the duration and distribution of inhibition in the sensory pathways. In con-

56. Cobb, S.: Electromyographic Studies of Experimental Convulsions. Brain **47**:57. 1924.

scious human beings (and to a certain extent in all higher animals) the latter process is subject to training.

In the induction of tetany by means of overbreathing in a large number of average normal persons I found the foregoing to be true. During the first experiments on any one person, disorientation set in much earlier and was much more profound than in subsequent experiments. Thus, simple mental tasks, such as breathing in synchrony with the expansometer and an easy rate of metronome beats, at first were difficult or impossible for some persons after the exercise was continued for ten or fifteen minutes. On succeeding days, however, the same persons could carry out increasingly difficult mental tasks, disorientation being postponed for increasingly longer times. And as the sensory state of the person was sustained for increasingly longer periods of time, the entire plexus of the tetanic manifestations was correspondingly postponed.

The same experiments carried out on epileptic persons produced similar results. In these patients, however, a tolerance for the tetanic state is acquired slowly. Once acquired such tolerance becomes manifest in every phase of their behavior. The difficulties of the procedure are sufficiently great, for both the physician and the patient, to make it impracticable as a treatment for epilepsy. The method, however, is so suggestive of a certain line of education for young epileptics and, besides, furnishes so much information as to the relation in which the sensory state stands to muscular activity, that a description of the procedure will prove of interest.

REPORT OF CASES

E. E., a girl, aged 13 years, had had some obscure illness at the age of 6 and, immediately following that, began to have minor and major epileptic seizures. The minor seizures recurred a great number of times (as many as sixty) each day, and the major ones, twice or three times a day. The statement of the parents is that until the age of 6, the child had been normal.

The patient's appearance was that of a hopeless idiot. She was well nourished. Her posture was stooping, the head hanging far forward. The mouth was open, the tongue was held between the teeth and saliva dribbled. Her speech was incomprehensible to any but her immediate family. It consisted of thick, explosive sounds, as if the tongue entirely filled the cavity of the mouth, and so difficult was the effort that it took a great deal of persuasion to get her to speak at all.

The tendon reflexes on the left side were greater than on the right. The associated movements of the left upper limb were increased. The abdominal and the plantar reflexes were normal. The cranial nerves were normal.

The patient's gait was awkward but not abnormal. On first trial her movements appeared to be ataxic. After several repetitions, however, it was found that she had no true ataxia. Thus, when requested to move her forearm up and down with the wrist and fingers extended, the latter would soon begin to flex, the fixation at the shoulder would become relaxed. After five or six movements of the forearm the associated postures became decomposed and the movement therefore became ataxic. After a number of trials, the postures needed for such movements

were sustained with increasing adequacy. The defect appeared to be due to an inability to associate the sensory experience of posture with that of movement. On testing each of these sensations separately they were found to be normal. The other sensations were normal as well.

The patient seemed to be mentally so inaccessible that it must be confessed that if it had not been for the insistence and a seemingly unaccountable optimism of her family, no attempt would have been made at systematic experimentation of so difficult a nature on a subject so apparently hopeless.

The patient was seen daily. For a number of days she was taught to associate the beats of the metronome with the act of breathing; and for another number of days she was taught to associate the divergence and approach of the hands of the expansometer with the depth of the respiratory movements. Then a new difficulty arose. After a dozen or so breaths in synchrony with the instruments, a minor seizure ensued. In a single sitting of half an hour she would thus have about a dozen minor seizures. As the breathing at this time was still very shallow and the rate of only twelve a minute, it was impossible to ascribe the seizures to an alkalosis. The following was then tried: instead of breathing, the patient was taught to move the forearm in synchrony with the metronome. Minor seizures ensued with about the same frequency as a result of the latter exercise as when it consisted in breathing. The seizures, then, must have been due to an abnormal facility of that sensory inhibition which is a normal part of the mechanism of attention. Thenceforth, the exercises, whether of breathing or of moving, were conducted with greater caution—six or seven movements at a time with a period of rest following.

In the course of months, the exercises were diversified in a variety of ways. Thus the patient was taught to touch each finger with the thumb, with the eyes open and closed, in synchrony with the metronome, to move the arm, or wrist, or foot, or to strike a hammer against the couch on which she lay in the same rhythm. Gradually her mentality appeared to emerge; and as it emerged, the power of sustaining orientation in spite of the onset of tetany as a result of overbreathing or of the concentration of attention, progressively increased. She became accessible to argument and correction. The exercises were then made more complicated.

Simultaneously with the increased tolerance of the tetanic state, the number of seizures decreased. After six months she had about one minor seizure a day and a very mild major seizure once a week. She had none during the exercises.

The experiments on this patient were continued for a year. At the end of that time her stature was erect, her mouth was closed and no saliva dribbled. Her speech, still thick, became intelligible. She learned to read and write with a satisfactory degree of clearness and fluency. Her movements were nearly normal. She had one minor seizure about twice a week and no major seizures.

Case 2.—R. D., a boy, aged 14, was afflicted with major epilepsy for fifteen months following a slight accident in a public conveyance. The seizures recurred on an average of three a week. The patient was of a twin birth, rather microcephalic and of dull mentality. Otherwise a neurologic examination revealed nothing abnormal.

Exercises in the acquisition of tolerance for the tetanic state were instituted daily. Great difficulty was experienced for the first three months. Disorientation set in so rapidly as a result of hyperpnea, and recovery was then so slow that little appeared to have been accomplished in an hour's sitting. Gradually, however, his tolerance increased. At the end of eighteen months the exercises were about as follows: The patient breathed deeply in synchrony with seven sounds of the metronome for each inspiration and five sounds for each expiration, at the rate of

twenty a minute. The depth of breathing was established by the expansometer. The patient at the same time counted mentally the total number of his respirations for thirty minutes during which the exercise was continuous. He did not have any seizures.

The exercises, which were then made more complicated by the addition of certain mental tasks, were continued for another six months, at first three times, then twice and at last once a week. Seizures did not occur.

A number of other epileptic patients were thus treated with varying degrees of success. In a few there was no improvement with respect to any diminution of the number or even of the severity of the attacks. Yet all were benefited in other respects. After two or three months persistence of the patients in the acquisition of a tolerance for the tetanic state, the uniform report of the parents or guardians was that there took place a decided change in the patient's intellect and character. They became more tractable, less impulsive and capricious and less given to ungovernable outbursts of temper, and they exhibited a greater inclination for intellectual pursuits, such as reading, for which most of these patients have a decided aversion.

SUMMARY AND CONCLUSIONS

There is a strong probability that all neuro-heredity statistics, including those of epilepsy, are in a way misleading. It is impossible to prove an inheritance of a defective nervous system as such. Generation after generation may be in possession of a defect consisting not only of a disproportion between the child's head and the mother's pelvis and pelvic organs, but of a defective correspondence between the special metabolism of pregnancy and the embryonic formation of the enormously complicated structure of the human brain. Even when epilepsy is apparently inherited from the father, it is unsafe to conclude that there is an inheritance of a defective brain rather than an inheritance consisting of a metabolic defect which by its action on the brain is the cause of epilepsy in both father and child.

That the arts of obstetrics and gynecology are adequate to save a number of lives of both mothers and infants, and even to reduce the percentage of intracranial damage, is an established fact. But no rational person can doubt that these recently arrived arts must perpetuate defects by enabling defectives to survive and to procreate. Whether the progress of the medical arts will outstrip and compensate for the increasing numbers of defectives in successive generations, or whether a point will be reached when the medical arts will be swamped by the number of defectives, only the future can show.

Epilepsy is a form of the tetanic state which has its origin in that normal inhibition of the sensory system which results in a release of muscular activity. The sensory and muscular manifestations of the

epileptic seizure are not essentially different from the processes of normal thought and normal action. The feature which distinguishes the epileptic seizure from normal thought, imagery and muscular activity, is an increased facility and generally a greater degree of nerve inhibition. If the wave of inhibition extends only a short distance along the sensory pathway and recedes before completely extinguishing the function of the association systems, then such a minor seizure is devoid of muscular manifestations. The same principle applies as well to the process of thought. The biologic significance of the latter process is, under these circumstances, a modification of the higher sensory pathways, so that future nerve impulses, in traversing them, will be correspondingly modified and will thus result in a corresponding modification of some future muscular reaction. The opinion, therefore, that thought is synonymous with muscular activity, has no basis in fact.

If the wave of inhibition, in both the epileptic seizure and the process of thought, extinguishes all or a part of the highest portion of the sensory pathway—the association systems of the cerebrum—then the function of the efferent systems becomes manifest to a corresponding extent. The mechanisms of posture may be observed in the epileptic seizure to manifest their function before those of movement. And this is in correspondence with the fact that, in normal muscular activity, certain joints must be fixed in posture before movement at other joints, in definite directions and for measured distances, is possible.

The convulsive postures and movements of the epileptic, when viewed in the prone position of the patient, appear to be irregular and absurd. Judged, however, as though the patient were in the upright position, they are unmistakably postures and movements which are integrated into normal patterns of muscular coordination. Outside of the occasional tremors and twitches which cannot be accounted for in the present state of knowledge, the movements are organized into complete and familiar acts which are frequently characterized by a considerable degree of beauty and grace. So varied are the acts of the convulsion in different subjects that it is not an exaggeration to say that there is hardly a normal posture-movement pattern which is not represented in the convulsion of the unconscious epileptic.

The various integrated movements of the epileptic convulsion, however, do not have reference to any coordinated acts which the person may have learned to execute in his conscious state. As a matter of fact, a number of the convulsive acts are such as the conscious epileptic is unable to repeat on request. The patterns of the coordinated movements and postures of the convulsion must, therefore, be inherent in the person's nervous system. Since the almost infinitely varied acts of the convulsion are not essentially different from normal integrated movements and postures, one may conclude that in normal persons the

patterns of posture and movement which are integrated into discernibly separate acts are inherent in the nervous system. Other things being equal, the ultimate success or failure of a course of training in the execution of any skilled act must, therefore, depend on whether the particular posture-movement patterns exist or do not exist in the nervous system of the particular person.

The detailed records of the various stages of the epileptic seizure show that the more profound the inhibition of the sensory system, the greater is the strength of the muscular contractions. Records of hysterical, of hysteroid and of tetanic movements indicate the same relation of the sensory state to the degree of strength of muscular contractions. The conclusion is therefore justified that a given degree of muscular contraction is normally conditioned by a corresponding degree of sensory inhibition.

In the cases observed in this study, no change of a given posture-movement pattern could be produced by stimulation of the peripheral receptors. The amount of afferent nerve function remaining in the unconscious epileptic patient during the convulsion must therefore be less than in the animal decerebrated by a section at the highest level of the midbrain. A change of pattern during the convulsion could, however, be produced through the medium of the proprioceptive mechanism. The evocation of such a change of pattern did not appear to have any influence in changing the act of which that, or the original pattern, was a constituent part. Thus, if the act could be recognised as one of "turning over," artificial restriction imposed on certain postures and movements which partake in the act resulted in postures and movements which accommodated the unrestricted to the restricted parts in such a manner as to achieve the act of "turning over" in a different way. The indication is, therefore, that the proprioceptive system is, during the convulsion, engaged in carrying out the details of acts presided over by a higher nervous system.

In the production of the manifestations of the epileptic seizure and of normal thought and action, inhibition operates on the well known principle of "release." A consideration of the converse of the phenomenon of release discovers explanations of certain puzzling physiologic and psychologic facts. Among these facts are the following: the existence of purely inhibitory pathways in the central nervous system; the inexcitability of the cerebral cortex outside of the pyramidal area; the frustration of certain reflex activities by volitional effort, and self-consciousness.

If the epileptic seizure is a form of the tetanic state which is distinguished from normal processes of thought and action merely by an increased facility of inhibition of the nerve pathways, then it must be subject to the same laws of training to which normal, mental and mus-

cular function is subject. Experiments on animals, such as those of Hammett [18] show that a tolerance for the tetanic state can be acquired by training, even when the defect is as definite as a want of parathyroid influence. That an increased tolerance for the tetanic state can be acquired by a certain course of training in human beings is also shown by the experiments on epileptic patients in connection with the present work. And although the method employed in these experiments is, on account of its great difficulty, impractical as a treatment for epilepsy, it is nevertheless suggestive of a certain line of education. The particular line to be pursued, however, must be left to the devices of the specialist.

THE CEREBRAL CIRCULATION

VI. THE EFFECT OF NORMAL AND OF INCREASED INTRACRANIAL CEREBROSPINAL FLUID PRESSURE ON THE VELOCITY OF INTRACRANIAL BLOOD FLOW *

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Our purpose in this investigation was to study the effect of alterations in cerebrospinal fluid pressure on the intracranial velocity of blood flow. In previous communications [1] were reported the results of direct observations through a tightly sealed glass window on the velocity of blood flow in cerebral vessels. By the method used, it was impossible to detect any but gross variations in the speed of blood flow. The following investigation was undertaken to study these changes more accurately.

METHOD

Preparation of the Animal.—Cats of approximately uniform size were used. The weights of the animals averaged 2.9 Kg., the largest differing from the smallest by 1.31 Kg. The heavier animals were pregnant, and so some of the weight may be discounted. Anesthesia was produced by intraperitoneal injection of from 8 to 9 cc. per kilogram of 1 per cent amytal (iso-amyl-ethyl barbituric acid). The animals were studied in the supine position. One cannula was placed in the trachea and another in the femoral artery. The left common carotid artery and its branches were exposed, and all the vessels except those entering the cranium were ligated with the greatest care. In a few animals, anatomic controls were made by the injection of colored fluid after all extracranial branches had been tied off. The head was then rotated so that the chin pointed to the right shoulder, and a needle, attached to a manometer filled with physiologic sodium chloride solution, was inserted into the cisterna magna. The cerebrospinal fluid pressure was then measured. By means of a reservoir connected through a side arm, T glass cannula, the pressure within the head could be increased to any desired height by raising the reservoir by pulley and line along a graduated pole.

Principle of the Measurement of the Velocity of Intracranial Blood Flow.—The velocity of blood flow was estimated by means of the radium method previously described.[2] The active deposit of radium, that is, radium C, was

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1. Cushing, H.: Mitt. a. d. Grenzgeb. d. Med. u. Chir. **9**:773, 1902. Forbes, H. S., and Wolff, H. G.: Cerebral Circulation. V: The Increase in Intracranial Pressure, Arch. Neurol. & Psychiat., to be published.

2. Blumgart, H. L., and Yens, O. C.: J. Clin. Investigation **4**:1, 1927. Blumgart, H. L., and Weiss, S.: Ibid. **4**:399, 1927.

injected into the common carotid artery (fig. 1 *A*), which had been previously prepared, and its time of arrival in the right auricle automatically recorded. The interval between the instant of injection and the time of arrival in the right auricle may be termed the "crude intracranial circulation time" and provides an estimate of the velocity of intracranial blood flow. Active deposit of radium is particularly suited to the purpose of such measurements because of its penetrating radiation, which consists of beta particles (or electrons) and gamma rays which are comparable to hard x-rays. These radiations can penetrate ordinary material such as tissues or air, but are absorbed by lead. Although the active deposit gives off radiations as it is carried through the cranial vessels and along the veins leading to the heart, the lead shield (fig. 1 *B*) prevents the radiation from reaching a sensitive detecting device which has been inserted within the centrally situated hole (fig. 1 *C*). This hole is placed immediately over the right auricle so

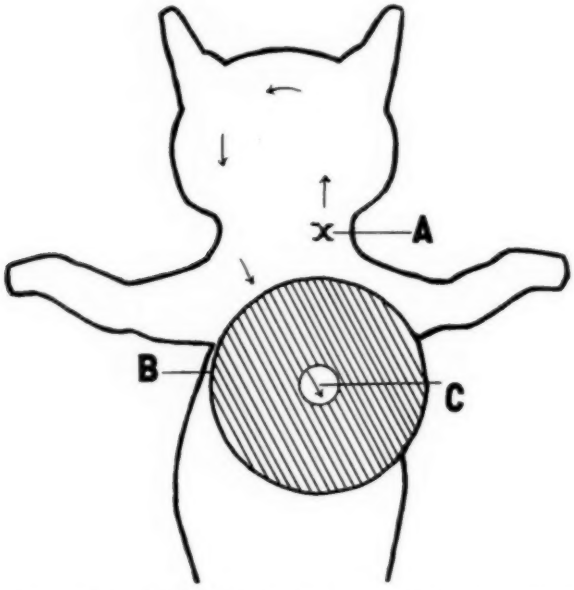

Fig. 1.—Diagram showing relation of the apparatus to the animal. *A* shows the site of injection of radium-active substance in the carotid artery. All extracranial branches have been ligated so that the radioactive substance passes only through the intracranial blood vessels. *B*, lead block (shield). *C*, hole in center of lead block containing sensitive detecting device which is placed over the right auricle. Arrows indicate direction taken by the radioactive substance from site of injection to the right auricle.

that, on the arrival of the active deposit within that chamber, the radiations are no longer separated from the detecting device in the lead but can pass through the tissues, traverse the air, enter the detecting device and there set up a train of events which produces automatic registration of the time of arrival of the active deposit within the right auricle of the heart.

Approximately 2 millicuries of active deposit in 0.2 cc. of sodium chloride solution, prepared according to the procedure described elsewhere,[3] was injected.

3. Blumgart, H. L., and Weiss, S.: J. Clin. Investigation **4**:389, 1927.

Adequate tests have shown that radium in the amounts used does not in any way affect the circulation. The injection was made through a small needle inserted directly into the common carotid artery. The time of injection was so short that it may be disregarded in calculation. The results are accurate to within 0.5 second.

The validity of the method used depends on the fact that there are no significant by-paths, so the active deposit of radium injected can reach the right auricle only by traversing the intracranial vessels. It is highly improbable that any error of consequence occurred in these studies because of the small anastomotic branches of the internal and external carotid arteries in the eye, nasal mucous membrane, ear, or through small intracranial branches of the internal carotid artery emptying directly into the external jugular vein.

Stewart,[4] using cats weighing about 2.5 Kg., measured the velocity of blood flow from the carotid artery to the external jugular vein without tying off any extracranial vessels. The time was 3.4 seconds. Under similar conditions, the time, by the radioactive method, was 3.5 seconds. Stewart observed that the circulation time of the retina was approximately 2 seconds. If, in accordance with other observations of G. N. Stewart,[4] one adds a correction of 3 seconds for the time it takes the fluid to go from the site of injection to the retinal artery and from the retinal veins to the right auricle, the total "crude retinal intracranial circulation time" would be 5 seconds. Since the time observed by us under the conditions of study was from 1 to 1.5 seconds longer (6+ seconds) than that probably necessary for the fluid to traverse the retina alone, it is proper to infer that not until the blood from the remainder of the intracranial circulation, chiefly the brain, entered the right auricle was the radioactive deposit present in sufficient quantity to give a definite, continuous record.

Further evidence that small anastomotic branches in no way distorted the results may be gathered from certain experiments in which the intracranial pressure was elevated above the systolic blood pressure. Under such conditions blood could not flow through the brain while the circulation through any possible extracranial branches would not be impeded. Although the occasional "stray" deflections under such conditions increased slightly, no premature onset that could be possibly confused with the usual abrupt beginning of the continuous oscillations was observed on the record.

RESULTS ON ANIMALS WITH NORMAL INTRACRANIAL PRESSURE

The "Crude" and the "Actual" Intracranial Circulation Time.—The time elapsing between the instant of injection of the active deposit of radium into the common carotid artery and its arrival in the auricle may be termed the "crude intracranial circulation time." The average of twenty-three measurements in twenty-three animals was 6.05 seconds. This time includes, in addition to the actual intracranial circulation time, the time of transit from the site of injection in the common carotid to the carotid canal, and the time taken by the active deposit in traveling along the veins from the cranium to the right auricle. The velocity of arterial blood flow is conspicuously rapid, particularly in vessels as large as the common and internal carotid arteries. We have not, by means of the radioactive deposit method, actually measured the

4. Stewart, G. N.: Am. J. Physiol. **58**:278, 1921.

velocity of blood flow in the arteries. According to Stewart,[4] the velocity of blood flow in the common carotid artery is from 50 to 55 mm. per second, indicating a correction of about 1 second for the distance traveled from the point of injection to the cranium. As the speed of blood flow in veins is about one-half that in the corresponding arteries, a total of about 3 seconds should be subtracted from the "crude intracranial circulation time" to give the "derived or actual intracranial circulation time." This time indicates the interval necessary for the radioactive deposit to flow through the intracranial vessels. Since the crude intracranial circulation time averaged 6.05 seconds, the average actual derived circulation time would be approximately 3 seconds.

Comparison with the circulation times of other organs is of interest. According to Stewart,[4] the most rapidly traversed capillary bed is that of the retina, 1.7 seconds. Next is that of the intestines with 2.5 seconds, and the coronary circulation, with from 2 to 3 seconds. The pulmonary, splenic, and perhaps the testicular circulation times come next, with an average of from 4 to 5 seconds. The circulation time of the kidney is between 6 and 8 seconds, and in a given animal is from 2 to 3 times longer than the pulmonary. The intracranial circulation time indicates, then, that the speed of blood flow through the brain is approximately as great as that of any other organ in the body with the single possible exception of the retina.

Relation Between the Intracranial Circulation, Time and the Weight of the Animal.—Stewart [4] found that an increase in body weight was generally associated with an increase in the circulation time through the lungs. In the present study such a relationship was not observed between the intracranial circulation time and the weight of the animal. The variation in weight of the animals of the present series was so slight, however, that other influences, such as the height of the blood pressure, might easily mask relatively small differences.

Relation between the Height of the Blood Pressure and Crude Intracranial Circulation Time.—Observations on the blood pressure were made simultaneously with the measurements of velocity of blood flow in each of the twenty-three cats studied. The blood pressure was estimated by means of a cannula in the femoral artery connected to a mercurial manometer. As already stated, the average crude intracranial circulation time was 6.05 seconds, while the average blood pressure was 116 mm. of mercury. The circulation times varied from 3 to 9.5 seconds; the blood pressure, from 66 to 184 mm. of mercury, as shown in the accompanying table. The variations in blood pressure were not caused by the injection of pressor or depressor substances. As can be seen from figure 3, increase in the height of the systemic blood pressure was generally associated with an increased blood flow; a low

blood pressure, with blood flow below the average of normal. With an elevated blood pressure of 180 mm. the intracranial circulation time was from 3.5 to 5 seconds, while with a blood pressure of only 66 mm. the circulation time was prolonged to 9.5 seconds. Although the general

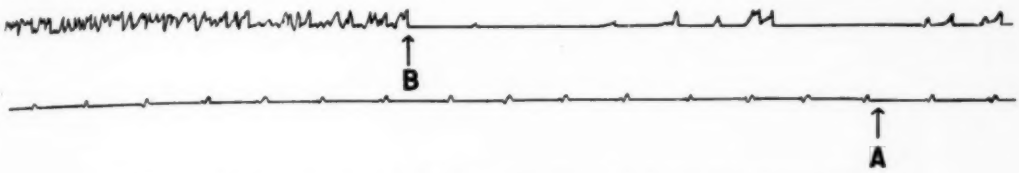

Fig. 2.—Tracing of record of experiment 23. The lower line shows the time in seconds; upper line, oscillations caused by the presence in the right auricle of radioactive substance. Radioactive substance injected at *A*. *B*, onset of electrical disturbances transmitted from sensitive detector over the right auricle. Velocity of intracranial circulation, 7.75 seconds. The presence of "strays" in the upper line before the true onset should be noted.

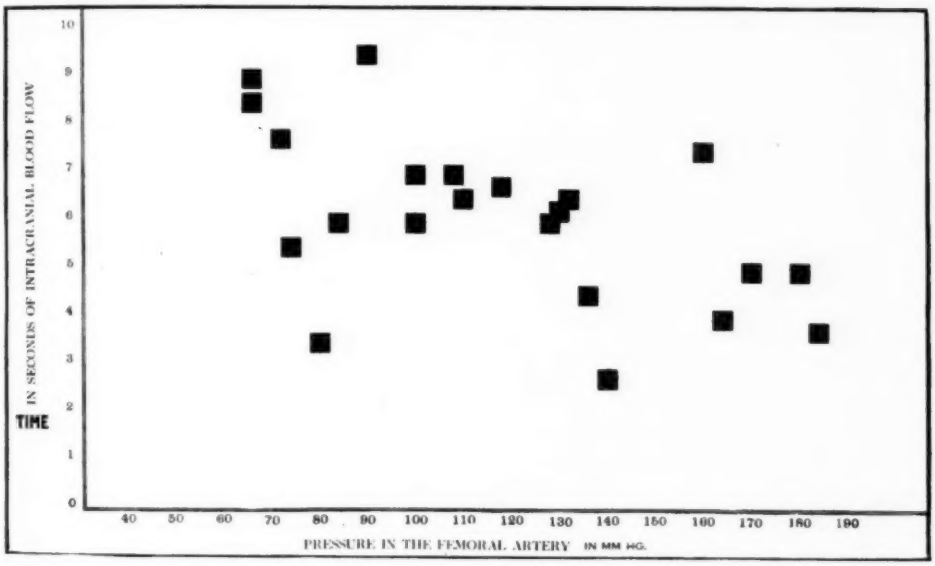

Fig. 3.—Demonstration of the relationship between the velocity of intracranial blood flow and the systemic arterial pressure. The velocity is greatest when the systemic arterial pressure is highest; with low blood pressure, the velocity is slower.

relation between blood pressure and rapidity of blood flow was definitely present, it did not obtain in each instance.

The relation between the velocity of blood flow and the systemic blood pressure is interesting in the light of observations by Lennox and

one of us (H. G. W.[5]), who found that with normal cerebrospinal fluid pressure a moderate lowering of blood pressure is usually associated with dilatation of the vessels of the brain. Further, Forbes, Lennox and one of us (H. G. W.) have demonstrated that sudden anemia, low oxygen or increased carbon dioxide cause cerebral vasodilatation. It was only with a conspicuous fall in blood pressure that narrowing of the brain vessels occurred.

On the basis of these observations, it may be inferred that those animals with a slow circulation time and low blood pressure had cerebral vasodilatation. This is significant since, even with considerable slow-

Relation Between Blood Pressure and Intracranial Circulation in Animals

Experiment	Weight, Kg.	Blood Pressure, Mm. of Hg	Crude Intracranial Circulation Time, Seconds
2	2.1	...	6.25
3	2.15	118	6.7
4	2.49	74	5.5
5	2.84	80	3.5
6	2.76	136	4.5
7	2.62	130	6
8	2.40	140	3
9	2.23	100	7
10	3.5	66	9
11	2.35	66	8.5
12	3.6	180	5
13	2.2	90	9.5
14	3.2	160	7.5
15	2.7	132	6.5
16	2.8	164	4
17	2.8	170	5
18	2.5	184	3.5
19	3.3	108	7
20	3.2	84	6
21	2.8	100	6
22	2.2	110	6.5
23	2.7	72	7.7
24	3.1	128	6
Averages (23 experiments)	2.76	117.8	6.05

ing of the blood flow, such a dilatation would permit an approximately normal volume flow of blood per minute.

RESULTS ON ANIMALS WITH INCREASED INTRACRANIAL PRESSURE

The clinical importance of understanding the intracranial circulation under conditions of increased cerebrospinal fluid pressure made it seem worth while to pursue our studies under conditions which allowed objective and quantitative measurement of some of the factors involved. Three types of increased intracranial pressure, frequently encountered clinically, were experimentally reproduced in eight animals.

1. Sudden Increase in Cerebrospinal Fluid Pressure Associated with Rise in Blood Pressure.—Sudden, conspicuous increase in the intracranial pressure, such as occurs in injury to the head or cerebral hemorrhage,

5. Wolff, H. G., and Lennox, W. G.: To be published.

was reproduced experimentally by abruptly raising the cerebrospinal fluid to the equivalent of 133 mm. of mercury. In each instance, the blood pressure soon rose. The crude intracranial circulation time was measured at various stages during this compensatory rise in blood pressure. In one animal in which the cerebrospinal fluid pressure was raised to 133 mm. of mercury, the circulation time was measured immediately while the blood pressure was still rising and before it was much in excess of the cerebrospinal fluid pressure. It was, in fact, only 2 mm. higher than the cerebrospinal fluid pressure. The crude intracranial circulation time was 13 seconds (average normal, 6.05 seconds). In another animal, the cerebrospinal fluid pressure was raised to the same height (133 mm. of mercury) and the crude intracranial circulation time was measured when the blood pressure was 140 mm., i.e., 7 mm. of mercury higher. The intracranial circulation time was 12.5 seconds, again indicating a slow blood flow through the head, approximately one-half the normal speed. In another animal, after the cerebrospinal fluid pressure had been suddenly elevated to 133 mm. of mercury, the crude intracranial circulation time was measured when the blood pressure had risen to 170 mm. of mercury, or 37 mm. in excess of the cerebrospinal fluid pressure. The circulation time of 8 seconds approached the normal more closely. Finally the intracranial circulation time was measured when, with a cerebrospinal fluid pressure of 133 mm., the blood pressure had risen 47 mm. higher. The intracranial circulation time was now 4.5 seconds and indicated a velocity of blood flow through the head, comparable to that occurring in a normal animal.

These observations demonstrate that, following an abrupt rise in the cerebrospinal fluid pressure, the velocity of blood flow through the intracranial blood vessels depends on the extent to which the blood pressure rises above that of the cerebrospinal fluid. This relation of the velocity of blood flow to the difference between the blood pressure and cerebrospinal fluid pressure is shown in figure 4.

The initial slowing followed almost immediately by an increase in the velocity of blood flow is in harmony with certain direct observations of blood vessels previously reported.[6] The compensatory adjustments to sudden increase in cerebrospinal fluid pressure probably involve the following sequence of events: The skull is a closed cavity so that a rise in cerebrospinal fluid pressure is transmitted to the other contents. The pressure of the cerebrospinal fluid and venous blood must therefore become almost identical. The rise in pressure within the veins and venous sinuses leads to stasis of blood. This stasis can be alleviated in either of two ways. If the rise in intracranial pressure is not great,

6. Forbes and Wolff (footnote 1, second reference).

it can be overcome by vasodilatation permitting the pressure within the larger arteries to be transmitted more readily through the smaller vessels, thereby overcoming the increased venous pressure and consequent venous stasis. If, however, as in the experiment just described,

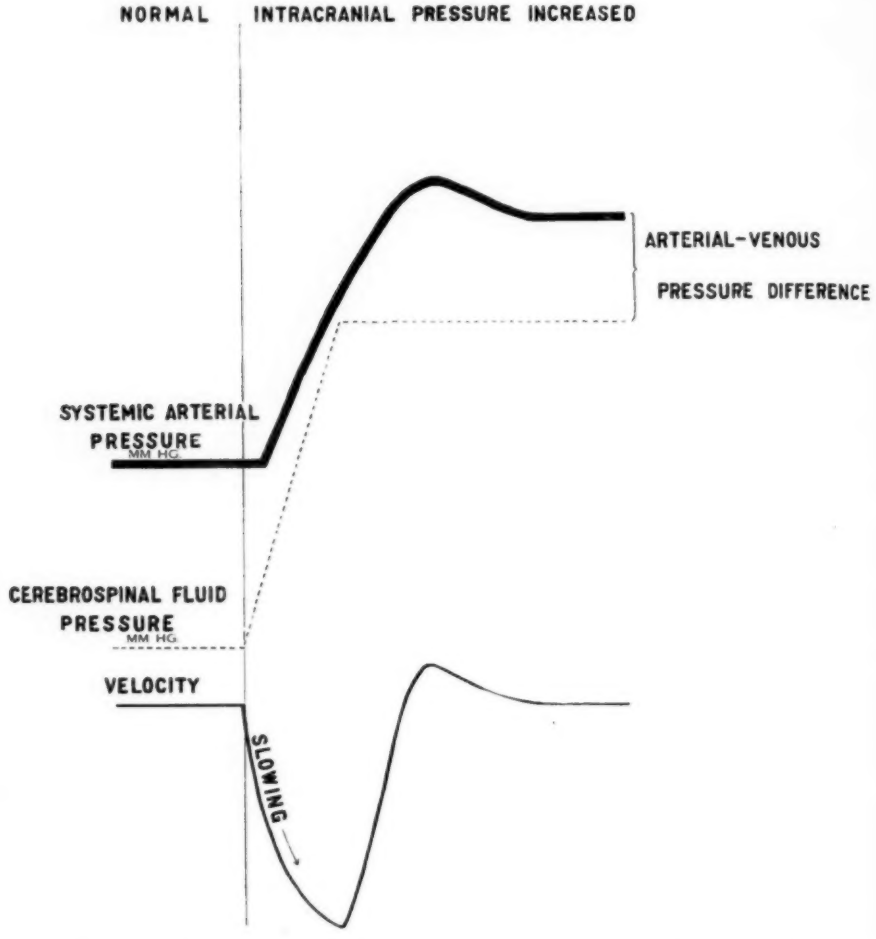

Fig. 4.—Schematization of the relationship between the velocity of the intracranial blood flow, the cerebrospinal fluid pressure (intracranial venous pressure, ±) and the systemic arterial pressure. As the intracranial arterial-venous pressure difference becomes less, the velocity of intracranial blood flow decreases; with increasing arterial-venous pressure difference, the flow again becomes more rapid.

the rise in cerebrospinal fluid pressure is greater, this venous stasis can be overcome only by a rise in systemic arterial pressure, which presumably results from stasis within the medulla.

2. Gradual Elevation of Cerebrospinal Fluid Pressure but Without Alteration in Blood Pressure.—Gradual increase in cerebrospinal fluid pressure without elevation in blood pressure, such as occurs in tumor of the brain, was reproduced experimentally by raising the intracranial pressure slowly to approximately 50 or 60 mm. of mercury. With an intracranial pressure of 55 mm. of mercury, the arterial-cerebrospinal fluid pressure difference (i.e., arterial-venous pressure difference) was 67 mm. of mercury. The crude intracranial circulation time was 7.5 seconds. In comparison with normal animals having similar blood pressure, the circulation time indicated that the intracranial velocity of blood flow was within normal limits or was slightly slowed.

In another experiment the intracranial pressure was 44 mm. of mercury, the blood pressure, 86 mm., and the arterial-venous pressure difference, consequently, 42 mm. of mercury. The observed intracranial circulation time was 10 seconds, indicating a distinct slowing of the blood flow.

The rise in cerebrospinal fluid pressure in these experiments was distinctly less than in the first series of experiments so that vasodilatation without elevation of blood pressure was presumably sufficient to overcome the venous stasis. Even with slowing of the velocity of blood flow under the conditions studied, the beforementioned vasodilatation probably permits a normal minute volume flow.

3. Rise in Cerebrospinal Fluid Pressure with Paralysis of the Vasomotor Center.—Measurement of the velocity of the intracranial circulation when the systemic blood pressure fails to rise after elevation of the intracranial pressure and when the cerebrospinal fluid pressure is greater than the arterial pressure shows that the intracranial circulation has stopped. For example, in one instance at the time of measurement the cerebrospinal fluid pressure was 44 mm. of mercury and the arterial pressure 32 mm. of mercury, or 12 mm. less. Although the heart continued to beat fairly forcibly, the radioactive substance never circulated through the brain, and the animals soon died.

The sequence of events seems to be as follows: The increased cerebrospinal fluid pressure is immediately transmitted to the veins, and the blood flow slows or ceases. If now the vasomotor center is depressed through previous prolonged partial anemia, drugs or injury, or if the cerebrospinal fluid pressure rises too abruptly, there is a sudden and almost complete anemia of the brain; elevation in blood pressure does not occur, the circulation in the brain ceases, and the animal dies. This indicates further that the blood flow through the brain is dependent on the arterial-venous pressure difference.

Thus there are several physiologic devices always active in keeping the amount of blood flowing through the brain nearly constant.

Fluctuations of short duration repeatedly occur, but these compensating mechanisms operate to keep constant the internal environment.

SUMMARY AND CONCLUSIONS

1. The average "crude" intracranial circulation time of the cat is 6.05 seconds. This indicates that in normal cats the average true circulation time of the brain is approximately 3 seconds.

2. In normal animals there is a definite relation between the velocity of intracranial blood flow and the height of the arterial pressure: the higher the blood pressure is, the faster the blood flow.

3. The velocity of the intracranial blood flow is dependent not only on the height of the blood pressure but primarily on the intracranial arterial-venous pressure difference.

4. If through an increase in intracranial pressure the arterial-venous pressure difference becomes small, the velocity of the intracranial blood flow is slowed. Through cerebral vasodilatation, the flow, though slower, is increased in volume and the circulation remains adequate. However, if the arterial-venous pressure difference becomes so small that the velocity is reduced to approximately half of the normal, the blood pressure rises, the arterial-venous pressure difference increases and the velocity of intracranial blood flow again approaches the normal.

5. Variation in the systemic arterial pressure and the diameter of the cerebral blood vessels, regulating between them the velocity and volume of the intracranial blood flow, apparently keep constant the internal environment of the brain.

ALZHEIMER'S DISEASE

A CONTRIBUTION TO ITS ETIOLOGY AND CLASSIFICATION *

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The disease process first described by Alzheimer,[1] and subsequently named after him by Kraepelin,[2] has since received consistent, if not frequent, proof of its existence as an entity. Many cases have been described that both clinically and anatomically were so much like those described by Alzheimer and Kraepelin that, as Gruenthal [3] put it, "If we were to describe as a typical case an artificial average in which the chief features of every single case would be represented, we would hardly get anything that would differ materially from the description of any one case." The proper clinical interpretation and definition of its relation to other conditions, however, has met with difficulties, most of which have been due to the original attempt to place it among presenile diseases. Kraepelin, in the edition of his textbook published in 1922, still voiced the opinion that "although the anatomic findings in this disease would speak for it being an especially severe type of senile dementia, the fact that at times the onset occurs in the early forties would be against such an assumption. Under such circumstances we would have to speak at least of a precocious senility, if indeed we are not dealing with a process more or less independent of the senium."

Kraepelin was prompted to make the statement by the fact that in some cases this condition may begin in the early forties, and when one realizes that some more or less typical cases of Alzheimer's disease have been reported as occurring even before 40, one must admit the possibility that this disease is independent of the so-called senium. Since senility as a concept cannot be restricted to changes in the central nervous system alone, and since the syndromes of senile nervous disturbances should remain within certain limits, one cannot help seeing that an extension of these boundaries to include processes occurring over such a wide range of age periods and showing so many variations

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* From the Foxborough State Hospital.

1. Alzheimer: Ueber eine eigenartige Erkrankung der Hirnrinde, Allg. Ztschr. f. Psychiat. **64**:146, 1907.

2. Kraepelin: Psychiatrie, ed. 8., Leipzic, J. A. Barth, 1922.

3. Gruenthal: Ueber die Alzheimersche Krankheit, Ztschr. f. d. ges. Neurol. u. Psychiat. **101**:128, 1926.

in clinical pictures would bring with it a loss of all definition of this concept. Even if it is true that the onset of this disease occurs most frequently between the ages of 52 and 63—a fact that would justify the assumption of its being a presenile condition—the possibility of its occurrence at decidedly earlier ages, in however few cases, would make some change in the concept of the disease necessary. If one wished to maintain its relationship to the presenile diseases, one would have to break the disease entity into groups; but if one wished to preserve it as an entity, one would have to establish it as such without relation to senility.

Gruenthal, in a study of thirteen cases of Alzheimer's disease, took the viewpoint that the cases hitherto reported with an onset before 40 were really not typical, either in clinical course or in the subsequent anatomic observations, of Alzheimer's disease. He is of the opinion that, for the present, they should be considered as not belonging to the Alzheimer group, and that the concept of this group as described by Alzheimer and Kraepelin should be preserved. It is true that some of these chronologically atypical cases have presented features that are opposed to the usual concept of this disease, although later we shall take exception to the analysis made by Gruenthal in other cases. If, however, it should be shown that cases both clinically and anatomically similar to the typical Alzheimer's disease do occur at an early age, the stand taken by Gruenthal would become untenable and a revision of the concept of this disease would be necessary. It is from this point of view that we have undertaken to discuss the clinical course and anatomic observations in two cases, both of which showed the changes found in Alzheimer's disease; they differed, however, clinically among other differences, in that one occurred at the usual age, whereas the other occurred early in life. Case 1 was in all points so typical that a description of it might well serve as a presentation of the textbook picture of this disease.

REPORT OF CASES

Case 1.—*History.*—E. Z., aged 65, was admitted to the hospital on July 30, 1927, with the statement that he was "confused and demented, and would not speak." The family history showed that the mother, who died at the age of 70, had "lost her memory" for a short time prior to death. The father, who died at 78, had, following an accident, been physically and mentally below his normal level for a few years prior to death. Other history of mental or nervous diseases in the family was not obtained. The patient was born in Switzerland in 1861. His birth and early development were normal. He was bright at school, especially in mathematics. He took up architecture and, previous to the onset of the illness, worked with an architectural firm. In 1921, an operation was performed on the prostate gland, but otherwise he had not had any illnesses. His habits were good; he did not use alcohol to excess. He married in 1889. He did not have any

children. Socially, he was not a good "mixer," but had always got along well with his friends. In 1905, he was sent west by his employers and worked there until 1921. He then returned east, but was unable to adapt himself to his previous level. His family attributed this to his being out of contact with conditions because of his long absence. The onset of the present illness was dated back, by the family, to September, 1924. At that time, he began to have "spells" in which his mind "seemed to be wandering." He told them that he had a feeling that his head was going around. There was not any buzzing or noise, however. At the same time, he seemed to forget things easily, and also showed difficulty in using the proper words in conversation. After a short period during which he had to remain at home, his mind cleared up, and he went back to work and apparently did well until September, 1925. Then a recurrence of the mental disturbance made him give up work again. The attacks became more frequent. The difficulties of memory and speech became more pronounced, and in August, 1926, he was admitted to the Boston State Hospital. There he was found to be disoriented in all fields, and he showed a marked impairment of memory. His speech was rambling. A sample of his speech there was as follows: "I came here—one, two, three, four—that gives you the better end—that gives you four of Hood's famous milk," and so forth. There was diminution of the knee jerks and slight tremor of the extended fingers; otherwise he was neurologically normal. He was transferred to another hospital, where he improved somewhat, but his memory remained poor and his speech was hesitant; he always showed a tendency to search for the word he wanted. He became quieter and more agreeable and in November, 1926, was allowed to go home. The family stated that he was comparatively well until about June, 1927, although he became progressively weaker and was unable to work. About June, he began to show a gradual decline. He became restless and confused. He could not find words with which to express himself and was unable to call things by their right names. He became untidy about his toilet habits and did not know what room he was in. He was restless and disturbed, began to accuse people of wanting to steal money from him; finally he was admitted to this hospital.

Clinical Examination.—On admission, he was well developed and fairly well nourished. He was semistuporous and there were some signs of involvement of the lungs. The blood pressure was: systolic, 178; diastolic, 70. The heart sounds were poor. The radial arteries were not sclerosed. A tumor mass was palpated in the right lower quadrant of the abdomen, and a large inguinal hernia was present on the left.

Neurologic Examination.—(Not altogether reliable because of poor cooperation). The ocular movements were apparently normal; the pupils were regular and reacted to light; the disks were normal, although there was a slight tortuosity of the vessels. Disturbances of the cranial nerves and paralyses were not definitely present, although there was some weakness on the right side. The deep reflexes were equal and hyperactive; the abdominal reflexes were not elicited. On the right side, there were suggestions of an Oppenheim and of a questionable Babinski reflex. Sensation was apparently normal. The patient had great difficulty in naming objects, responding mostly with stuttering and the utterance of unintelligible sounds. A watch was said to be a mirror, and so forth. He obeyed simple commands but could not carry out more complicated ones. When given a pencil and told to write, he attempted to do so with the wrong end touching the paper. A sample of his speech follows: Q.—When did you come here? A.—"Wednesday . . . . no, ca— ca— . . . came over about . . . about what . . ehe . . came about . . came about . . just ab— . ." Q.—When did you come here? A.—"Yes." Q.—

What date is it today? A.—"What did they do to it barber . . well . . certain sections. For instance you will find . . . 1—2." Q.—Why did you come here? A.—"They had a . . formerly . . formerly . . had a weak man. It was weak . . but fine fam . . . this . . . fine fam . . . it is." He could not write intelligibly. When told to sign his name or to copy it, he made a few unintelligible marks on the paper, holding the pencil in an awkward position. Further mental examination was not possible, owing to the difficulty of establishing contact with the patient. He was apparently dioriented and confused, and did not show any signs of recognizing those around him, even relatives. He smiled in a silly manner, but did not give any indication of his real mood. His thought content was unavailable both on account of the lack of contact and on account of the marked disturbance of speech. He was restless, picked at people's clothes and was untidy and at times impulsive.

The urine was normal. The spinal fluid showed one cell, and negative globulin and gold tests. The permeability index (by the Walter method)[4] was 2.49. The Wassermann reactions of the blood and the cerebrospinal fluid were negative.

Course.—The patient continued to be restless, and grew gradually weaker; he did not show any definite focal signs. On August 11, he became stuporous, and on August 14 he died. The clinical diagnosis was Alzheimer's disease and tumor of the abdomen.

Postmortem Examination.—The heart was somewhat enlarged; the valves were normal. There was moderate arteriosclerosis of the arch of the aorta and slight arteriosclerosis of the coronary arteries. The lower lobe of the right lung was markedly edematous but was otherwise normal. At the upper part of the cecum, adjoining the ileocecal valve, there was a tumor, measuring 16 by 10 cm., which on histologic examination was found to be an adenocarcinoma. Metastases were not found. The liver showed slight fatty degenerative changes; otherwise the organs were normal. The brain weighed 1,335 Gm. The meninges were normal. The larger blood vessels were all delicate. Sections through the brain did not reveal gross changes.

Histologic Examination.—Pia Mater: The pia was thickened, and with the thionin stain appeared as a deeply stained purplish-red margin. The different elements were diffusely proliferated. The nuclei of the fibroblasts were swollen; the protoplasm stained moderately and was oval in shape. There were large masses of green pigment, either lying freely in the network or taken up by the fibroblasts. The vessels also showed a series of changes: in many there was thickening of the walls, consisting of ringlike layers encroaching on the lumen, which was occasionally totally obliterated. Other vessels showed a mild degree of hyaline-like degeneration in the walls. These changes were mostly found in the frontal, temporal and occipital lobes, being especially marked in the last.

Cortex: With the Nissl stain (fig. 1), sections of the temporal lobe showed, in the first cortical layer, diffusely distributed corpora amylacea accompanying the pial changes. The second and third layers were occasionally rarefied, whereas the lower layers were better preserved. The neuroglial reaction was moderate and confined to a more or less energetic proliferation of the scavenger cells with rare plasma cells. At times, isolated Hortega forms were encountered, but astrocytes were not seen. The Nissl picture was completed by a moderate vascular proliferation and a slight swelling of the endothelial cells. Features of a similar character, but of much less intensity, were also observed in other parts of the cortex.

4. Malamud, Wm.; Fuchs, D. M., and Malamud, N.: Studies on the Blood-Cerebrospinal Fluid Barrier, Arch. Neurol. & Psychiat. **20**:780, 1928.

The ganglion cells showed a fairly definite but unspecific disturbance. The architecture of the cortex was only slightly disturbed, and in most places was fairly well preserved, with only occasional rarefactions. The vessels in the other areas were similar to those of the temporal lobe, showing slight proliferation with moderate increase in the perivascular oligodendroglia and deposits of green pigment (similar to that described in the pia) in the adventitia. Not anywhere in the cortex were signs of arteriosclerotic or inflammatory changes found.

With the Bielschowsky stain, the most important pathologic conditions were noted. At the first glance one could see the whole variety of typical senile plaques

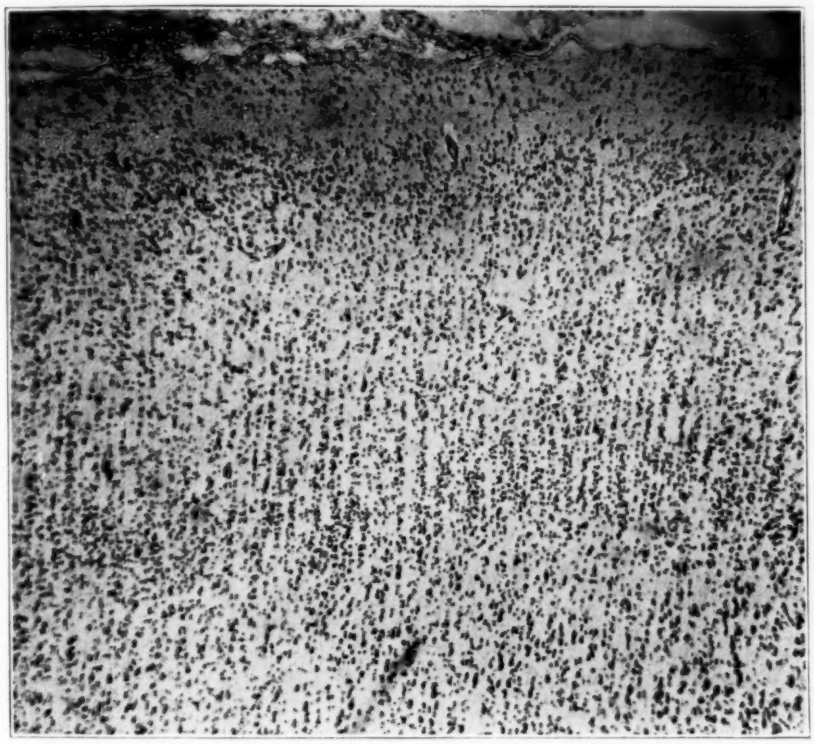

Fig. 1.—The typical picture of the cortical involvement in a case of Alzheimer's disease. Nissl stain; × 40.

scattered throughout the cortex (fig. 2). The nerve cells had undergone profound changes, mostly of the intracellular fibril type described by Alzheimer (fig. 3), although there were also less specific forms of degenerative changes. The Alzheimer fibril changes were widely distributed throughout the different parts of the cortex and practically all the forms described by Alzheimer and other authors were represented. The well known basket-like forms with winding fibril changes were especially numerous. There was also marked destruction of the fibrils in the different stages of the disease, such as fragmentation, thickening, club formations and so forth. The reticulum was transformed into a dustlike detritus. These changes were most marked in Ammon's horn and neighboring regions of the

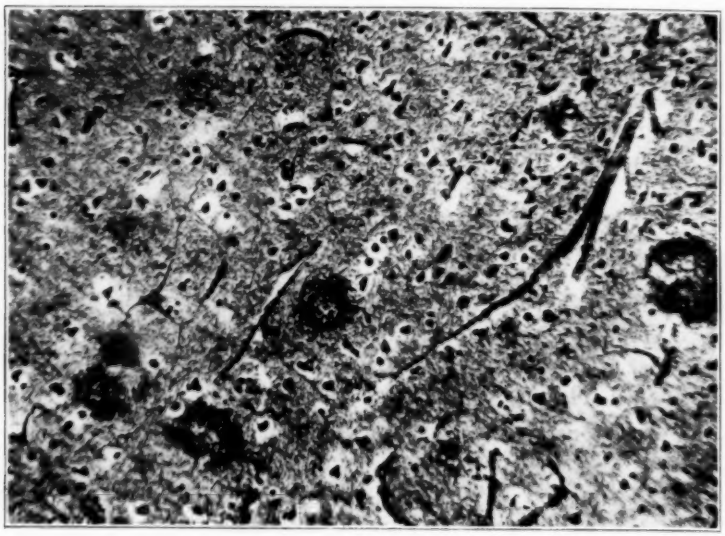

Fig. 2.—Typical senile plaques in Ammon's horn. Bielschowsky stain; × 80.

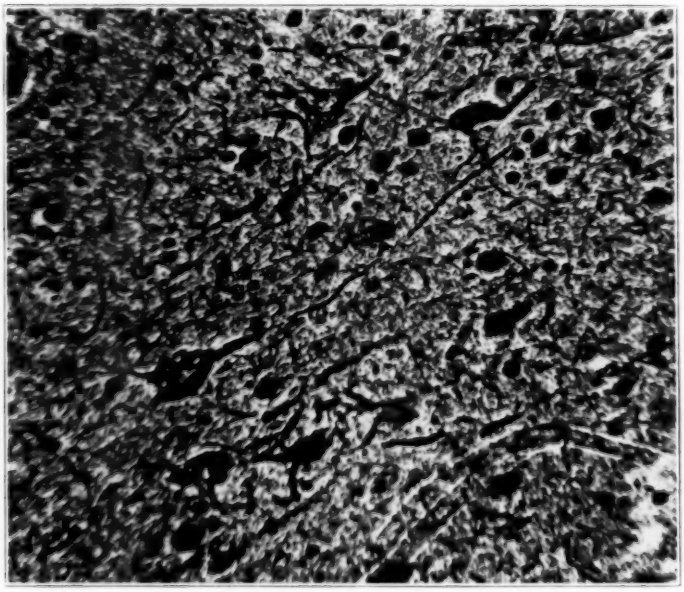

Fig. 3.—Alzheimer's fibril changes. Bielschowsky stain; × 200.

temporal lobe (presubiculum and subiculum), in which both plaques and Alzheimer cell changes occurred in large numbers. The other parts of the brain were affected to a less degree. Plaques could be seen everywhere, being well represented in the anterior central convolution, somewhat less in the occipital, parietal and anterior frontal regions. The Alzheimer cell changes followed the same distribution, but were rare in the frontal and parietal regions, and not found at all in the occipital pole.

In sections stained with sudan III and scarlet red, only a slight amount of fat was found in different parts of the brain, deposited either in the cell bodies themselves or in the vessel walls.

With Weigert stains, sections showed a few changes in the form of slight rarefactions of the myelo-architecture.

With Victoria blue stain, only a slight increase in the fibrous glia was found in Ammon's horn.

Sections prepared with Hortega stains showed isolated microglia cells in different parts of the cortex.

Basal Ganglia: With Nissl stain, a pronounced disturbance was found in the putamen. The neuroglia cells showed intense proliferation with formation of nodules and occasionally more diffusely spread foci. The type most frequently met with was the protoplasmic cell. With these, however, numerous Hortega cells could be demonstrated. The parenchymatous tissue, too, had undergone marked change. Most of the cells were destroyed, leaving only cell shadows and detritus. Throughout the tissues there were large deposits of greenish pigment, lying either freely in the surrounding tissues or within the different types of Hortega cells, as well as in the macroglia elements. In the pallidum and the thalamus, the disturbance was much less marked, most of it being restricted to the parenchymatous tissues, with less pronounced neuroglial changes and only moderate deposits of pigment.

Plexus Choroideus: With the van Gieson stain, the epithelium was well preserved, and changes were not observable in the forms of the villi. There was slight proliferation of the connective tissue with occasional mild hyalinization. The capillaries were generally delicate and contained blood, although in a few the lumen was closed by a thrombus. There were isolated stonelike concretions and corpora amylacea.

Stains for the demonstration of iron, according to the Turnbull method, showed rich deposits of iron throughout the different sections of the brain, mostly, however, in the thalamus, in which the presence of iron was discernible even to the naked eye. Iron was found mostly freely distributed between the tissues. Occasionally, however, it was accumulated in the microglia elements.

Summary.—A man in whose heredity there was a tendency to senile psychosis and whose history previous to the onset was essentially unimportant, began to show signs of mental disturbance at the age of 62. These consisted at first of spells of dizziness, defects of memory and disturbances of speech. Following an apparently complete remission, the symptoms recurred for another short period, to be followed by a less complete remission of a few months. This, in turn, was followed by an uninterrupted progression of the disturbance of memory and mild paranoid ideas. On admission (fifteen days before death) he was semistuporous, and showed only slight indication of paresis

on the right side with questionable pyramidal tract signs. There were disturbances of speech in the form of aphasia and paraphasia, as well as a tendency to logoclonia. There was definite apraxia, difficulty in obeying commands other than of the simplest type, and disturbances of writing and copying. He was restless, impulsive and untidy in his habits. The urine did not show any pathologic features; the Wassermann reactions of the blood and the cerebrospinal fluid were negative. The fluid did not show any pathologic changes other than slightly increased permeability. Postmortem examination showed a carcinoma of the cecum and mild arteriosclerosis. The brain did not show gross changes, but histologically it revealed the following outstanding features: numerous plaques and Alzheimer cell changes throughout the cortex, with the exception of the occipital pole, which did not show the latter; degenerative phenomena in the ganglion cells and neuroglia, especially marked in the basal ganglia, and mild degenerative phenomena in the vessels of the cortex and the pia, but not any signs of arteriosclerosis or inflammation. The choroid plexus showed changes that at the age of the patient are to be considered mild and nonspecific. The presence of rich deposits of iron completes the picture of a pronounced degenerative disease of the brain.

Comment.—One is dealing here with a case of Alzheimer's disease, typical both in clinical course and picture, and in pathologic features. The age of onset falls well within the limits described by the different authors and would fit into the symptom-complex described by Alzheimer and Kraepelin, as well as that described by Gruenthal. This case, furthermore, in view of the age of the patient and some features of the clinical picture, could be regarded as belonging to the presenile group without great difficulty. One may agree with Gruenthal that most cases are remarkably like this and can be regarded as presenile. As was mentioned, however, some authors have described under the general concept of Alzheimer's disease cases in which the onset occurred at an age that must be placed definitely outside the presenile limits. Gruenthal's opinion was that all such early cases hitherto reported were not actually Alzheimer's disease; as there are only a few of them, we will present a brief review of them:

1. Schnitzler's Case[5]: The patient was 32 at the onset of the disease. The case was marked by general retardation, progressive dementia, focal signs, absence of aphasia or apraxia and pronounced thyroid deficiency (myxedema). Anatomically, there was an atrophic brain and Alzheimer cell changes, but no plaques. We agree with Gruenthal that this case neither clinically nor anatomically fits into the Alzheimer group.

5. Schnitzler: Zur Abgrenzung der sogenannten Alzheimerschen Erkrankung, Ztschr. f. d. ges. Neurol. u. Psychiat. **7**:34, 1911.

2. Schaffer's Case[6]: This man, aged 28, died with a clinical picture of hereditary spastic spinal paralysis; in the anterior central convolution numerous Alzheimer cell changes were found, but not any plaques. This case too, as pointed out by Gruenthal as well as by Schaffer himself, should not be designated as a case of Alzheimer's disease.

3. Weimann's Case[7]: The patient was 37 at the onset, and the clinical picture showed some similarities to Alzheimer's disease, though some points differentiated it. Histologically, plaques were not found. Therefore, this case does not fit into the picture we are discussing.

4. Barrett's Case[8]: The patient was 31 at the onset of the disease. The clinical course was characterized by gradual progression and death of the patient at the age of 37. The clinical picture was that of gradually increasing restlessness, confusion, mental deterioration, disturbance of speech and consistent and definite focal signs (ataxia, spasticity of the arms and the legs, definite pyramidal tract signs, and so forth). Postmortem examination showed a greatly atrophied brain, numerous plaques and Alzheimer cell changes, with degeneration of the anterior and lateral pyramidal tracts as well as pallor of the posterior columns.

Although the picture in Barrett's case is not altogether typical of Alzheimer's disease, we cannot agree with Gruenthal that this case should be considered as altogether outside the limits of this classification. It seemed to us that in this case one should really consider the question whether this is not Alzheimer's disease within the picture of a more widely distributed central nervous system process. The pathologic changes in the brain, as well as the clinical picture, when one discounts the focal signs, would otherwise fit into the usual Alzheimer picture. Focal signs and symptoms have been reported in this disease before, although they were not so extensive. It seemed to us that these somewhat unusual observations were overemphasized because they occurred in a case that was chronologically outside the presenile limit. This objection to extending the concept of this disease to include other than chronologically presenile cases seems to us to be challenged especially seriously by our own second case.

CASE 2.—*History.*—E. H., aged 15, was admitted to the hospital on June 15, 1918, with the statement that "he was mute, untidy, destructive to clothes and bedding, would not eat, and was noisy and cataleptic at times." The family history did not show any hereditary taints; there had been one miscarriage; five siblings were living and well. The patient was born in November, 1902. The pregnancy and birth were normal. The early development was normal: the boy walked at the age of 1 year and 4 months and talked at the age of 1 year. There had not been any convulsions or injuries. The parents said that the patient had been bright, mentally normal and not different from other children up to the age of 7; then he had an attack of scarlet fever. He had started in school at 6, and

6. Schaffer: Ueber hereditaere spastische spinal Paralyse, Deutsche Ztschr. f. Nervenh. **73**:101, 1922.

7. Weimann, cited by Gruenthal (footnote 3).

8. Barrett: A Case of Alzheimer's Disease with Unusual Neurological Disturbances, J. Nerv. & Ment. Dis. **40**:361, 1913.

had gone through the first grade. Following the scarlet fever, he did not progress well in school. He had to repeat the first grade and then attended different schools up to the age of 14, never progressing further than the third grade. As time went on, he became more and more "shut-in," did not play with other children and grew gradually more stupid. He remained rather simple and childish. About Christmas, 1916, he developed acute excitement with sleeplessness and extreme restlessness. He recovered from the acute excitement, but his general mental condition became gradually worse and in July, 1917, he was admitted to a State school for feebleminded children. He apparently got along well there for a while, but about April, 1918, began to show signs of psychotic behavior. (This was said to have followed consecutive swellings of both eyes for which an adequate cause could not be found.) He became restless and withdrew more and more from his environment. About the beginning of June, he became entirely mute, destructive of his clothing and violent to other children. At night, he would refuse to stay in bed, would bite and chew things. He was finally transferred to Foxborough State Hospital for the Insane with a diagnosis of "psychosis with mental deficiency."

Examination.—On admission, the patient was physically well developed and nourished. The pupils and cranial nerves were normal. The heart was normal, but the lungs showed signs of an old tuberculous process. The blood pressure was: systolic, 112; diastolic, 74. The genitals were underdeveloped. Paralyses and sensory and coordination disturbances were absent. The deep reflexes of the two sides were equal, although somewhat exaggerated; pathologic reflexes were not present. The Wassermann reaction of the blood was negative. Mentally, the boy was apathetic and indifferent. He answered questions in monosyllables, with a tendency to perseveration, and was disoriented for time and place; he knew his name and age. His grasp of the surroundings was defective, and his memory was poor. Delusions and hallucinations were not brought out. He was rather careless about his personal appearance, and somewhat untidy in his habits.

Course.—On admission, the patient had an attack of infectious arthritis. The leukocyte count was 12,000. This cleared up, and two months later he was up and about, helping with the ward work, and showed some grasp of his surroundings. He knew the name of the place from which he came and knew that he had two brothers and two sisters, although he could not remember their names. He knew the names of the physician and of the nurse. After a few months, however, he began to show inefficiency in his work and a tendency to annoy other patients by picking at their clothes. In March, 1919, he showed restlessness, walked up and down the ward at night and was noisy. Physically, he did not show changes. By February, 1920, he had stopped doing any work at all, and was becoming progressively worse mentally. In June, 1920, a neurologic examination did not show any change other than disturbance of speech, with thickness of tongue and use of wrong words. He was still disturbed and noisy, and had to be kept on the ward. At times he was apprehensive, thinking that robbers came into his room. In the early part of 1921, there was a slight improvement. He was quiet, but his answers were inaccurate. (Unfortunately, verbatim samples of his speech at this or any other examination were not recorded.) About April, 1921, however, he became disturbed again, restless, and extremely uncleanly in his habits, smearing and ingesting fecal matter. At times, he would show extreme muscular spasticity, but not any definite focal signs. He would pick at his nose, scratch his face, throw himself about in bed in an impulsive manner. The spasticity increased, and at the beginning of May, 1921, he remained in bed, semistuporous, with extreme muscular tension. He would take nourishment, however, when it was set before

him, but was negativistic and would not talk. In June, he had to be fed by spoon. Physical examination at that time did not show any change. About the end of 1921, the patient, although still showing muscular tension and occasional impulsiveness, began to improve somewhat. At the beginning of 1922, he had become quiet and was up and about the ward, but was still getting into difficulty with other patients.

By February, 1922, he had improved considerably and was taken out against the physician's advice. He remained with his parents until August, 1926. In January, 1923, it was reported that he was getting along well and was helping a neighbor on a milk route. During the interview, he seemed to take more interest in things. He knew the physician's name. He answered simple questions, but seemed not to understand more complicated ones. In December, 1923, he visited the hospital again. There was not much change. Similar notes were made on the occasions of visits in November, 1924, and October, 1925. About the beginning of 1926, however, there was a turn for the worse. He had had a cold about that time, and, although physically not very ill, began to show signs of mental disturbance. He became restless, noisy, untidy and impulsive. He was cared for at home up to August, 1926, but was becoming progressively more disturbed and confused. His speech became "mixed up," so that the people could not understand him, and finally, on Aug. 23, 1926, he was returned to the hospital.

At that time, he showed negativism and mutism, not answering questions put to him. He seemed not to have any grasp of his surroundings, and was extremely untidy in personal habits. He had to be kept in bed. Physical examination did not show any signs except the old tuberculous lesion in the lungs. He gradually declined both mentally and physically and began to show signs of infiltration of the lungs. At the end of September, he developed a temperature of 102.6 F., with numerous râles over both lungs. The temperature rose gradually. Signs of neurologic local lesions were not observed. The reflexes were increased but were equal on the two sides and pathologic reflexes were not observed. The cranial nerves, as far as could be tested, were normal. He remained mute except for occasional unintelligible sounds. He did not show any apparent reaction to outside stimuli. The physical condition became worse, and he died Oct. 5, 1926, with what was diagnosed clinically as psychosis with mental deficiency and tuberculosis of the lungs.

Postmortem Examination.—There was a caseous abscess in the upper lobe of the left lung with an old adherent pleuritis and a similar, but less marked, condition in the upper lobe of the right lung. The mesenteric glands were enlarged. Other than that, all organs were normal.

Brain: The meninges were grossly normal. The superior surface was somewhat injected; otherwise, changes were not grossly visible. The brain weighed 1,330 Gm.

Histologic Examination.—Pia Mater: The pial vessels were delicate. They did not show proliferative or inflammatory phenomena. In the network of the pia, as well as in the adventitia of the pial vessels, there were fairly large amounts of green and black pigment.

Cortex: With the Nissl stain (fig. 4), a marked disturbance of the parenchyma was apparent. All cortical layers were involved in a process of rarefaction of the tissues, and the cells stained poorly. The rarefaction was of a diffuse type without any tendencies toward focal accentuations. The character of the cell changes was the same throughout. All the cell components were involved. The cell stained poorly and the details of its structure were not discernible. The nucleus was indistinct and the processes were not visible. The neuroglia was

involved to a less degree, showing some rod cell accumulations and occasional protoplasmic cells. The vascular system was not affected, but there were moderate amounts of greenish-black pigment throughout the cortex, mostly around the vessels. The intensity of the disease process was practically the same throughout the cortex, although it was somewhat more marked in Ammon's horn, whereas the architecture of the occipital lobe seemed to be affected least.

With the Bielschowsky stains, the pathologic process was especially well demonstrated. The number of nerve cells was markedly decreased. Numerous cells

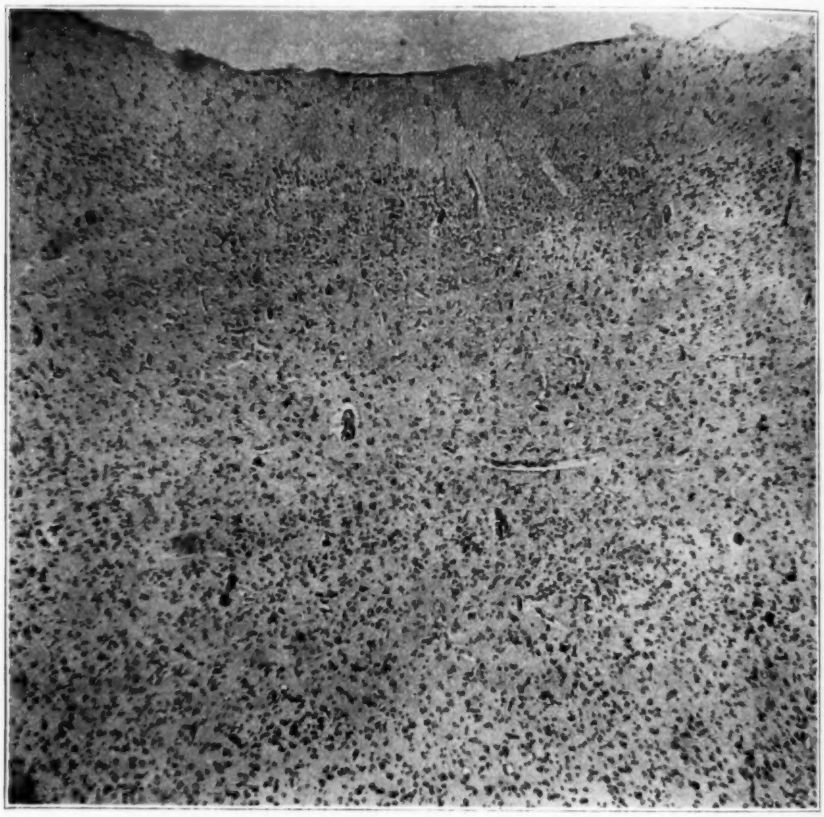

Fig. 4.—A typical picture of the cortical involvement in the case of E. H. Nissl stain; × 40.

had undergone complete destruction leaving only masses of detritus, but most of them, while still retaining the general outline, showed marked degenerative changes of different types (fig. 5). The most prominent type was that of the Alzheimer fibril change; it was represented without exception in all areas of the brain, being intense even in the occipital region. Different types and stages of this change were seen. Numerous senile plaques were found throughout all parts of the cortex (fig. 6). The fibrils were affected, as was also the reticulum, in forms usually met with in descriptions of Alzheimer's disease—thickening, clubbing, fragmentations, etc. The different components of this process reached their highest intensity

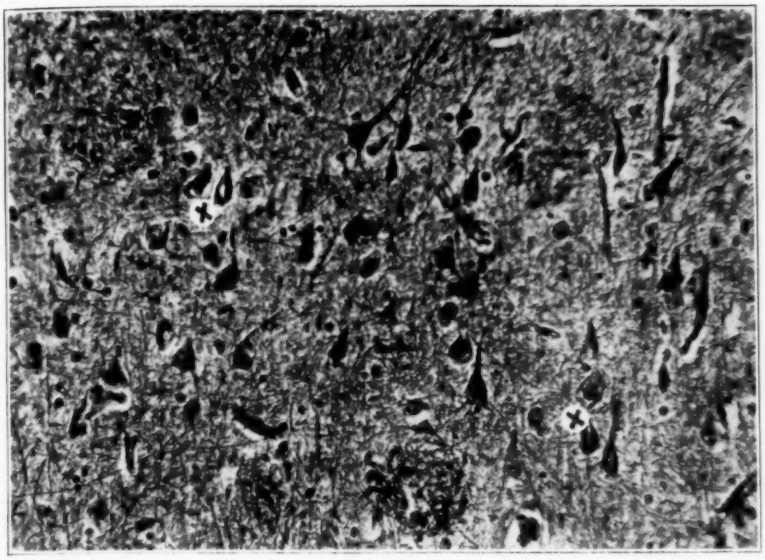

Fig. 5.—Alzheimer's fibril changes (x), involvement of the reticulum and senile plaques. Bielschowsky stain; × 200.

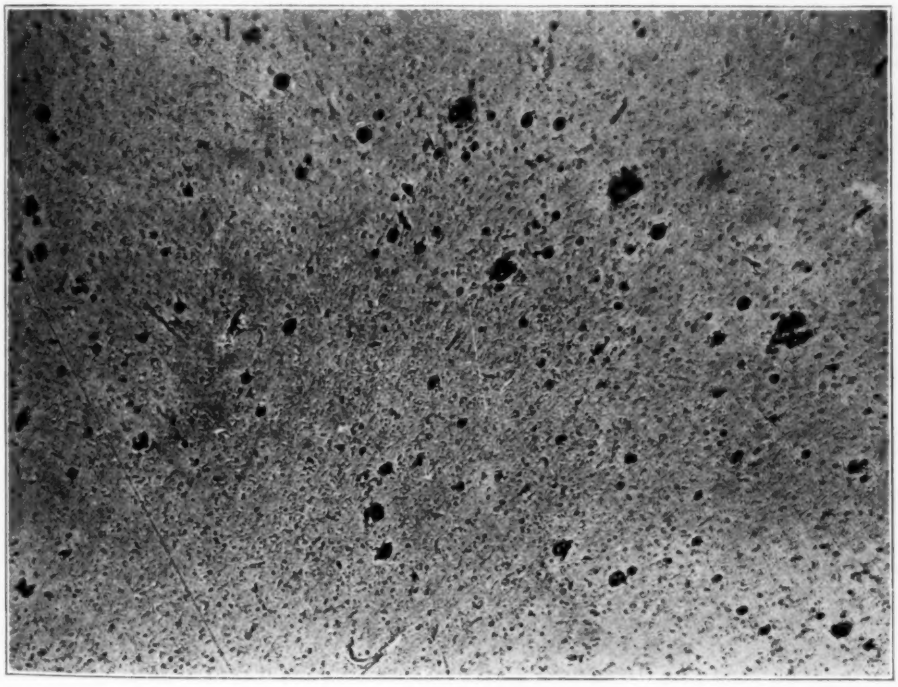

Fig. 6.—Numerous senile plaques. Levaditi stain; × 40.

in Ammon's horn. There the senile plaques were particularly numerous and of an unusually large size. Most of them were without the central area of necrosis and consisted of a solid clump of black fibrils. The largest numbers occurred along the thick band of Ammon's horn formation, but they were also well represented in other areas of the temporal lobe. In these latter, however, the character of the plaques changed, and in the Th formation (Economo and Koskinas' nomenclature) they showed the definite necrotic center usually seen in these structures. Both Alzheimer fibril changes of the cells and destruction of the reticulum and fibrils were well represented throughout. An interesting phenomenon could be observed in some of the vessels in sections stained by this method. In the occipital lobe, some of the capillaries were surrounded by rings of necrotic tissue, the origin of which could not be ascertained because a cellular structure could not be observed in the material constituting the ring. The vessel wall itself appeared somewhat thickened and homogeneous. These changes were similar to the plaquelike bodies that have been described by one of us (K. L.) on another occasion.[9] As to the relationship of the blood vessels to the plaques in general, one could say only that occasionally capillaries were noticed running through plaques (especially in the frontal lobe, but also in the temporal and other areas). In other places, some of the vessels were surrounded by plaques. In the white matter, sections stained by this method did not show either plaques or any other changes.

The sections stained with sudan III and scarlet red showed practically no fat. On rare occasions, small quantities of fat were found in some of the cells or around an isolated blood vessel.

With the Weigert stain, there was shown a mild disturbance of the myeloarchitecture with diffuse rarefication, but not any definite focal degenerations.

With Victoria blue, a mild proliferation of the fibrous glia in Ammon's horn and the temporal lobe was seen. Otherwise, deviations from the normal picture were not in evidence.

Basal Ganglia: With Nissl's stain, the histologic picture of the putamen was practically the same as that described in the first case. The only difference between the two was in the vascular changes. In this case, the walls of some of the larger vessels were conspicuously thickened and contained homogeneous bodies of a hyaline-like character. The quantity of pigment in this case was even greater than that in the first, its distribution being the same. The changes in the caudate and the thalamus simulated those in case 1.

With Bielschowsky's stain, the basal ganglion cells, the pons and the medulla showed marked degenerative changes in the parenchymatous tissue, but not any senile plaques or Alzheimer changes in the cells. The neuroglia cells in the pons and the medulla did not show any tendency to proliferation, although there were some solitary protoplasmic cells and isolated Hortega glia; there were not any astrocytes.

Cerebellum: In contradistinction to case 1, this case did not show pathologic changes in the cerebellum. With the Nissl stain, as well as the Bielschowsky and neuroglia stains, the parenchyma, vessels and neuroglia tissues were all normal.

Plexus Choroideus: With the Van Gieson stain, of the three plexus components—the vessels, the connective tissue and the epithelium—the vessels were the most intensely affected, and therefore will be described first. A general view demonstrating the intensity of the vascular changes as well as their relationship to other structures was best obtained by a low magnification of the plexus of the left

9. Lowenberg: Die Histopathologie und Histogenese der Plaques Seniles, Ztschr. f. d. ges. Neurol. u. Psychiat. **95**:549, 1925.

lateral ventricle (fig. 7). At first glance, one could see the greatly thickened wall consisting of layers concentrically arranged about the lumen, encroaching on it and in most cases obliterating it entirely. A few of the vessels, although markedly thickened, still contained some blood. Surrounding these vessels and supporting them were thick masses of proliferated connective tissue. The whole plexus was thus transformed into a rigid, massive structure. On the outer edges of the villi, only a narrow band of epithelial cells was recognizable. At one point, a small part of the plexus showed a different picture. The vessels here were dilated and appeared like hemangiomas (fig. 8). They were filled with blood and there was little connective tissue between them.

Under higher magnifications (fig. 9), the concentrically arranged layers were seen to be of a homogeneous structure, staining diffuse reddish yellow. In the

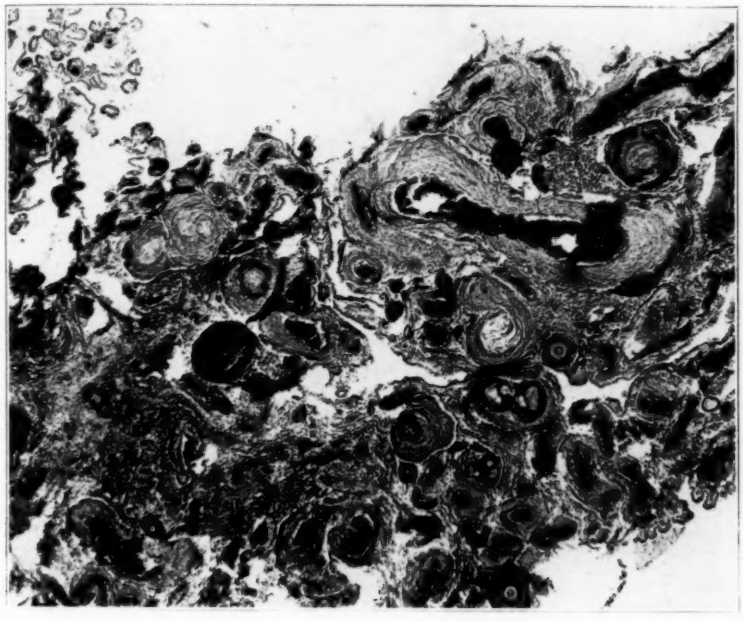

Fig. 7.—A general view of a section of the plexus of the left lateral ventricle. Van Gieson stain; × 40.

center of the obliterated vessel there was a structureless mass, somewhat like a thrombus and of a grayish tinge. A series of different forms of these changes could be seen, differing in staining capacity as well as in structure. In some of the vessels, the concentrically arranged rings were not quite distinct but had a well defined dark-gray central body. In others, the central structure consisted of a light-gray homogeneous ring surrounding indefinite rigid masses and finally, in some of the vessels, there was a preservation of the lumen, which was surrounded by a margin of dark-gray or black necrotic tissue. In a few of the diseased vessels there was only hypertrophy of the walls, the lumen still containing blood. In these latter, the elastica stain showed several thick elastic layers (fig. 10).

There was little in the structure of these vascular changes to point to a possible origin of the process. In most cases, it seemed to have run its course leaving little

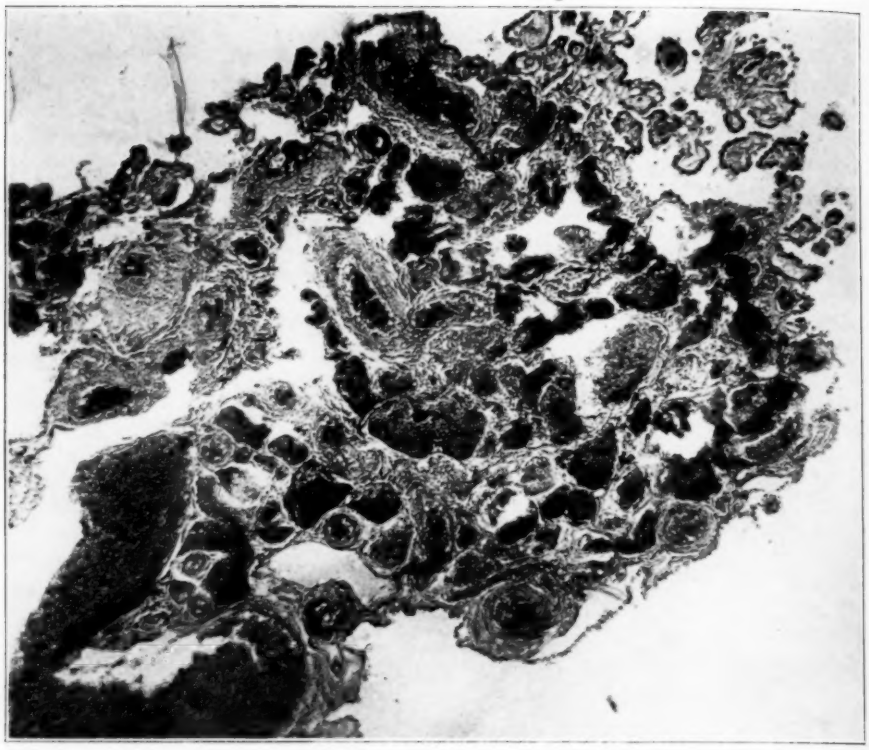

Fig. 8.—Hemangioma-like vessels in the plexus. Van Gieson stain; × 40.

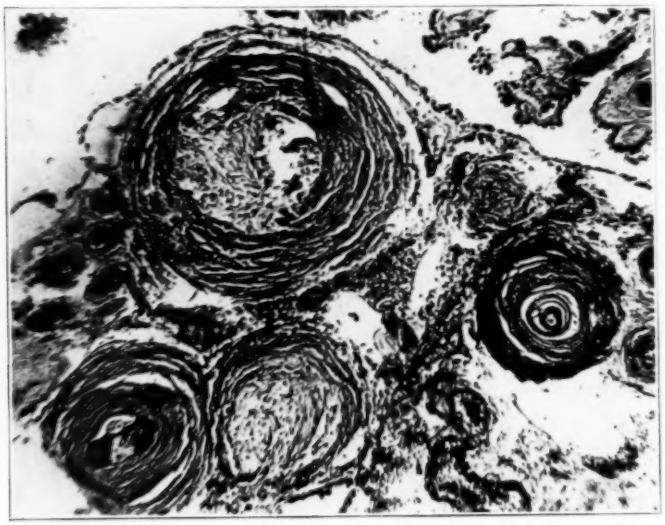

Fig. 9.—Concentrically arranged layers of the vessel walls and proliferation of the intima. Van Gieson stain; × 80.

behind to indicate the nature of the previous stages. Even when the thickening of the walls was not marked, their structure was one of homogeneous hyalinization without anything specific. Vessels that were apparently still in the process of transformation were met with only rarely. In such vessels, the media was affected in a manner already described. The intima of these vessels, however, showed energetic proliferation. The cells were of a fine elongated form each with a definite nucleus and narrow band of protoplasm. Occasionally there was a formation of giant cells. The lumen was not altogether obliterated, although here, too, there was thickening of the fibrils and destruction of the nuclei.

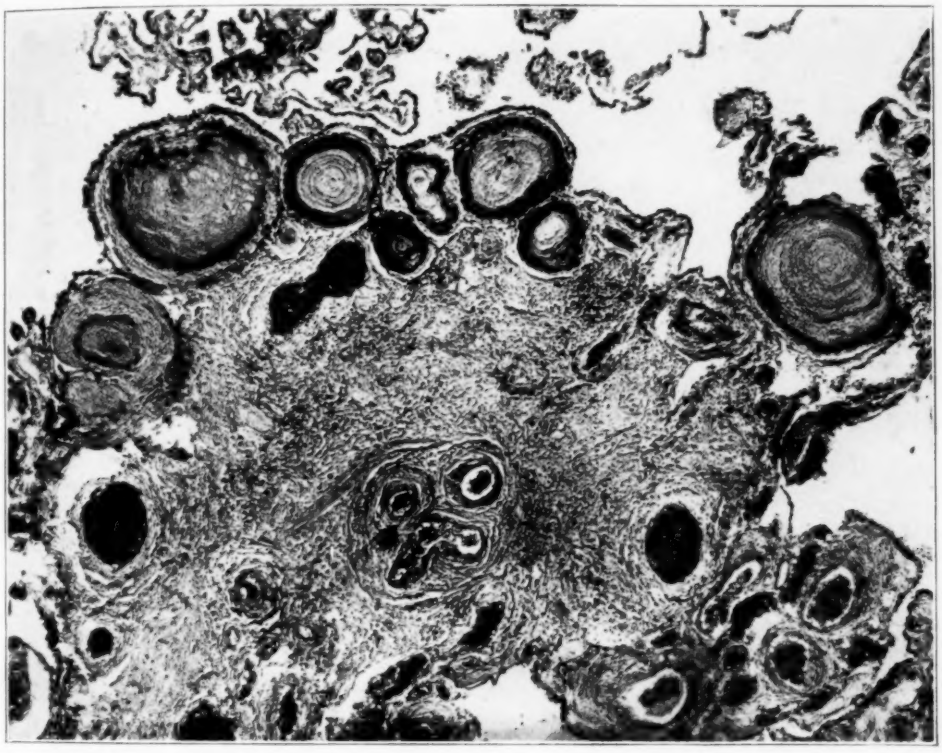

Fig. 10.—A typical single villus. Van Gieson stain; × 40.

The pathologic process in the plexus was widely distributed throughout both sides. The picture described represents the condition of by far the largest part of both plexuses and only occasionally were small sectors encountered in which the disease was less marked; normal plexus tissue was practically absent. The process was more marked on the left than on the right side. In the plexus of the right lateral ventricle, one could still find some parts that had undergone changes more or less similar to those that have been described by other authors: a fairly advanced proliferation of the connective tissue and thrombosis of the capillaries, but without the peculiar changes that we have described. On this side, too, there were some capillaries that were only slightly affected, the walls being delicate, the lumen filled with blood and the surrounding tissues practically normal; even on this side, how-

ever, these more or less unaffected areas were in the decided minority. Most of the plexus here, as well as on the left side, when examined in serial sections showed the changes that we have described.

Not anywhere in the sections examined were there changes of an inflammatory or arteriosclerotic nature. Calcified areas were not found anywhere in the vascular system. The plexus of the fourth ventricle was not available for study.

Summary.—Following an infectious disease at the age of 7, the patient, who is said to have been normal before, showed a gradually progressing mental disorder expressed in inefficiency in school work and asocial tendencies. This chronic picture led to periods of excitement, restlessness and impulsiveness, which necessitated confinement at first in the State school for the feebleminded, and later in a State hospital for mental diseases. Here there was a further mental decline, with acute exacerbations alternating with periods of quiescence. Following a period of intense disturbance, characterized by muscular tension, mutism alternating with rambling speech, impulsiveness, extreme untidiness, confusion, apprehensiveness and so forth, there was another period of quiescence during which the patient was taken home, where he remained for more than four years. During this period, he is said to have been fairly tractable although needing somewhat constant supervision. This was followed by a final exacerbation which began about six months before death, apparently associated with a slight respiratory infection and with mental symptoms that were like those of previous occasions. They were characterized especially by extreme restlessness, confusion, untidiness about toilet habits, wandering at night and disturbances of speech, which were, however, not fully described. He was finally returned to the hospital. Death occurred from exacerbation of an old tuberculous process.

At postmortem examination, there was found an acute tuberculous process, but not any other gross lesions. The brain showed histologically: (1) an extremely advanced, typical picture of Alzheimer's disease, with numerous plaques, Alzheimer cell changes and fibril degenerations, and associated with it a marked nonspecific degenerative process throughout the cerebral cortex and basal ganglia, the cerebellum being intact; (2) a condition of the choroid plexus consisting of an extensive degenerative process of the vessels of the villi. The lumen in most of these was completely obliterated by concentrically arranged rings of structureless substance in the walls. Some of the vessels, however, were still patent and contained blood. The connective tissue surrounding the blood vessels (especially the capillaries) was greatly increased and showed signs of an advanced degenerative process. The epithelial layer was represented by a thin margin on the periphery; the individual cells were degenerated.

Comment.—Clinically and pathologically, this case presents some features which are not usually met with in the Alzheimer disease syndrome. In the clinical picture, one finds the following points that may speak against such a diagnosis:

The Duration: It is difficult to establish with certainty the duration of the disease process that culminated in the final picture. There is not a doubt that the definite change at the age of 7 was in some way or other related to it. Therefore, on the one hand, one might consider it as the onset of the psychosis. This would give a duration of seventeen years. On the other hand, there is a possibility that the change at the age of 7 marked the onset of the plexus disease, which, even if causative of Alzheimer's condition, may have gone on for a period of time without it. Under such conditions, one would have to consider Alzheimer's disease as having begun at the age of 15, and its duration as nine years. Either of these periods of duration, however, would exceed the limit of what is considered the average for the disease. It is possible that these limits are not correct. In our case 1, the duration as given by the relatives, was four years; on further questioning, however, we found that for about four or five years previous to that, the patient had shown some change in his ability to adapt himself to his work. This brings up the possibility of similar situations in other cases, and it may be simply a question of how acute and striking the onset has to be before relatives recognize the change. Furthermore, cases have been reported that have had a duration as long, or even longer than our case (Barrett's case [10] of over twenty years' duration, Bett's case [11] of about twenty years, Gruenthal's two cases [3] of twenty and thirteen years' duration and others). This fact, then, even if rendering the case somewhat atypical, does not preclude the diagnosis of Alzheimer's disease.

The Remissions: In our case 2, after the establishment of the typical clinical picture with definite progression, there was a remission (more or less complete) that lasted about four years. In Gruenthal's reports, as well as in those of other authors, particular mention is not made of remissions. Unfortunately, the cases that have had protracted courses (those reported by Barrett, Gruenthal, Betts, and others) are not reported in great detail, and it is in such cases that one might expect periods of remission or standstill. But even our case 1, which ran a course typical of this disease, showed after the first acute attack a remission that lasted about a year. The return to normal during this remission was so distinct that the patient actually performed his

10. Barrett: Degenerations of Intracellular Neurofibrils, Am. J. Insan. **67**: 503, 1911.

11. Betts, cited by Fuller: J. Nerv. & Ment. Dis. **39**:440 and 536, 1912.

work on a level similar to that of his previous state. This, even if unusual, is not incompatible with the course of Alzheimer's disease.

The Exceptionally Early Onset of the Disease: There is no question but that in regard to age our case 2 is the only one of its kind; but, as we have stated in introducing the subject, this factor was really the one that prompted us to consider a revision of the Alzheimer disease concept, and we must repeat that if cases clinically and pathologically typical of Alzheimer's disease do occur at different ages, Kraepelin's idea that this disease may really be independent of the senile group must be seriously considered.

Pathologically, as can be seen from the description, the process differs only from the typical Alzheimer's disease in a very marked plexus affection. The proper evaluation of the latter and its relation to the changes in the brain must be preceded by a consideration of the following two questions.

1. To what extent is the process pathologic in a person of this age? In the literature on the subject, the work of the Monakoff [12] school, and especially of Kitabayashi,[13] stands out as the most valuable on the physiologic and pathologic changes in the plexus. This author has found that normally the choroid plexus of persons below the age of 20 should not show any changes. The endothelium, capillaries, and connective tissue are delicate at this age; hyalinizations, thromboses in the capillaries, and other changes have not been noticed. Following this, there is the beginning of an extremely slow increase in the connective tissue, so that even at the age of 30 years the only noticeable change may consist in a slight widening of the perivascular spaces, the connective tissue of the villi usually remaining delicate. Slight thickenings of the connective tissue and occasional hyaline deposits may be found in rare cases. In contradistinction to this, we find in our case, at the age of 24 years, practically a total transformation of the whole organ. We must regard this as a marked pathologic disturbance. Added to this is the fact that changes of this type were found only in the plexus, and not anywhere else, either in the brain or in any other organ.

2. What is the nature of this pathologic process, and are there reports of similar observations in the literature? Kitabayashi distinguishes three groups of plexus changes in his investigations of persons who showed physiologic as well as pathologic plexus disturbances: (*a*) alterations having their origin in the interstitial and perivascular mesodermal tissues (proliferation, cystic degeneration and

12. Von Monakoff: Biologie und Psychiatrie, Schweiz. Arch. f. Neurol. u. Psychiat. **4**:1, 1919.

13. Kitabayashi: The Choroid Plexuses in Organic Disease, J. Nerv. & Ment. Dis. **56**:21, 1922.

vascular processes) capable of bringing about secondary transformation of the ependymal cells; (*b*) chronic and acute alterations arising in the glandular ependymal tissue, and (*c*) mixed mesodermic and ectodermic alterations.

Our case does not quite fit into any one of these groups. We are dealing here apparently with a primary vascular disturbance of a type somewhat different from that described by Kitabayashi. The proliferation of connective tissue is probably secondary. The involvement of the epithelium, the dilatation of the veins and the changes in some of the arteries that have not been affected in the fashion described must be regarded as more or less mechanically conditioned. The whole histologic picture can only be explained on the basis of a primary vascular disease. Where the vessels are only slightly or not at all affected, as is the case in some of the villi, the other structures, too, remain uninvolved. As the vessel wall begins to be transformed, however, into a thick-walled rigid tube with a subsequent total obliteration of the lumen, the surrounding tissues undergo a gradual change as an adaptation to new conditions. The connective tissue, which under normal circumstances supports a network of delicate capillaries, is now called on to adapt itself to a much heavier structure and it undergoes a suitable change. The process of hyalinization of the tissues, too, we regard as being merely a consequence of altered nutrition and pressure, an occurrence which is not unfamiliar in general pathologic processes. With this, of course, there is also a gradual change in the epithelium; for, as the whole villus increases in size, its shape being distorted and its components transformed, the epithelium is crowded out toward the periphery and the cells themselves undergo mechanically produced changes.

As to the question of the origin of this disease, we have no means of forming any adequate interpretations. So little is known of the pathology and physiology of the plexus and the possible causes of changes in it that a definite answer is not possible. Notwithstanding the marked and extremely variable changes in this picture, we have not found any signs that could be interpreted as indicative of either inflammatory or arteriosclerotic processes. Furthermore, the development has been apparently so slow, the various stages have merged into one another so imperceptibly and the whole process has been so thoroughly completed that a possible pathogenetic history of it could only be guessed at.

For similar reasons, it is rather difficult to come to any conclusion as to the relationship between the process in the plexus and the pathologic changes in the brain tissue. Was the one causative of the other? Were they associated in any other fashion, for example, caused

by an etiologic factor common to both? Or were they totally independent of each other? Whereas definite answers to these questions cannot be attempted, we must say that on the face of it, the plexus disease is logically assumed to be the one of longer duration and probably primary to the other. The solution of this aspect of our problem was rendered especially difficult by the absence of similar reports in the literature. Nowhere in the case reports that we have studied (those referred to as well as those of Perusini,[14] Bielschowsky [15] and Fuller [16]) was any mention made of the condition of the plexus. A comparison of our two cases, however, shows at least the possibility of the occurrence of Alzheimer's disease without striking changes of the plexus, as, for instance, in case 1. (It is interesting in this respect that in case 1 we found in the pial vessels a disease process more or less similar in nature, although of much less intensity.)

COMMENT ON THE ETIOLOGY

Should we assume that the condition of the plexus in case 2 played a more or less important rôle in the etiology of the disease, we would be forced to accept a multiplicity of etiologic factors in the causation of the same clinicopathologic process. This, of course, is not without analogies in medicine and especially in neuropsychiatry. The pathologic changes in rabies, for instance, show, histologically, great similarity to those of encephalitis, and so do the changes in some cases of paresis and of alcoholism. With the assumption of a possibility of more than one etiologic factor in the production of a process clinically and pathologically within the limits of the concept of Alzheimer's disease, we avoid the difficulty in placing case 2, as well as the case of Barrett, under the common heading of Alzheimer's symptom-complex, although we must discard the notion of its being particularly bound to a certain age.

From a pragmatic point of view, there is not any particular advantage in regarding the whole group as an expression of presenile changes. Etiologically and pathogenetically, one knows little about the process of senility other than that it may be produced by some unknown metabolic changes. By retaining the concept of precocious senility as causative of the changes in Alzheimer's disease, therefore, one states nothing definite about them. Aside from this, we have seen that such an attitude would render even the concept of senility more obscure and its boundaries less definite by necessitating the assumption of the occur-

14. Perusini: Ueber klinisch- histologische eigenartige Erkrankung, in Nissl and Alzheimer: Arbeiten, 1909, vol. 3, p. 297.

15. Bielschowsky: Zur Kenntnis der Alzheimerschen Krankheit, J. f. Psychiat. u. Neurol. **18**:273, 1911.

16. Fuller: Alzheimer's Disease, J. Nerv. & Ment. Dis. **39**:440 and 536, 1912.

rence of such changes over such a wide range of age periods. Some, too, of the pathologic changes that are common to both Alzheimer's disease and senility have been reported as occurring in other disease processes (Schaffer's case). If it is true that a certain well defined clinicopathologic picture can occur at different age periods and apparently be produced by different etiologic factors, then the common link must be looked for in the pathogenesis of the process. The possibility of a disturbance of the plexus producing a picture of this type in the one case would offer a stepping stone toward discovering such a common factor. The results of recent investigations into the physiology of the plexus, and the possible rôle it plays in the exchange of substances between the blood and the cerebrospinal fluid (a rôle which it may share with other structures such as the cerebral capillaries and meninges), give valuable clues as to the direction to be followed. The changes that take place in the plexus with age even normally may be of further assistance.

CONCLUSIONS

At present, however, we feel justified in summarizing as follows:

1. The pathologic picture described by Alzheimer is a well recognizable entity.

2. It is found in cases that show clinically a well defined symptom-complex, but may also show individual peculiarities.

3. Etiologically, this clinicopathologic syndrome may be caused by a variety of factors. The fact that a great many of the cases, in fact most of them, occur at a presenile age would make one think that, in a group of these cases, the etiologic factor may have something in common with that which is causative of such changes in senility. This does not exclude, however, the possibility that factors altogether independent of senility may also bring about the same condition.

PSYCHOSIS IN PAGET'S DISEASE (OSTEITIS DEFORMANS)*

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A disease of the skeletal system producing as much disturbance, especially of the external conformation of the skull, as osteitis deformans would naturally lead one to question its effects on the nervous system. *A priori,* one would expect mental symptoms to be a frequent concomitant. Actually in reviewing the literature, one is struck by the rarity of such symptoms in these patients.

In his original article in 1876, Paget [1] stated that "even when the skull is hugely thickened and all its bones exceedingly altered in structure, the mind remains unaffected."

Wyllie [2] maintained that the nervous system is rarely affected. According to him, the capacity of the cranium is actually increased; the anteroposterior and transverse diameters are greater. The vertical measurements, however, especially around the foramen magnum, are decreased. The neural foramens are narrowed, and symptoms may thus arise. He mentioned two cases of pressure on the optic nerves with atrophy.

Retinal and choroidal changes are fairly common. Of twenty-three patients, four were blind, three from retinal hemorrhages and one from choroiditis. He attributed the hemorrhages to arteriosclerosis rather than to compression.

Gregg [3] emphasized the actual compression of the cranial nerves and reported neuralgias, paralyses and disturbances of the special senses.

Moynan [4] recently reported a case of Paget's disease with psychosis in which the essential symptoms were apathy and impairment in the intellectual spheres. The retinas showed advanced arteriosclerosis and engorged veins. Basing his formulation on Knaggs' [5] conception of a toxic etiology, he believed that the arterial changes were due to the

* Submitted for publication, Aug. 14, 1928.

1. Paget, J.: Osteitis Deformans, Lancet **7**:14 (Nov. 18) 1876.

2. Wyllie, W. G.: The Occurrence in Osteitis Deformans of Lesions of the Central Nervous System, with Report of Four Cases, Brain **46**:336, 1922.

3. Gregg, D.: Neurologic Symptoms in Osteitis Deformans (Paget's Disease), Arch. Neurol. & Psychiat. **15**:613 (May) 1926.

4. Moynan, R. S.: Osteitis Deformans with Psychosis: Report of a Case, Ohio State M. J. **24**:20 (March) 1928.

5. Knaggs, R. L.: Osteitis Deformans (Paget's Disease); Relation to Osteitis Fibrosa and Osteomalacia, Brit. J. Surg. **13**:206 (Oct.) 1925.

same toxic process that caused the osteitis. Necropsy revealed chronic glomerular nephritis, general arteriosclerosis and compression of the brain.

A. Marie's [6] patient suffered from diabetes insipidus, epileptic attacks and fugues which cleared up under pituitary therapy. X-ray examination showed an eroded sella. To Marie this was sufficient proof of the pituitary etiology of osteitis deformans. His patient also presented many paranoid ideas. Marie termed the mental picture "délirante hypomanique." At the same meeting, he also exhibited specimens from six patients on whom necropsies were performed at the Villejuif, but did not give any details of their mental reactions.

The case reported by Fitz [7] was "complicated with rheumatic arthritis, arterial degeneration, chronic valvular disease and lastly, with mild melancholia accompanied by delusions."

Mental symptoms are not prominent in the cases reported by Watson,[8] Hurwitz [9] and Gillam.[10] The last mentioned author stated that atheromatous changes in the arteries are found constantly in this disease.

My purpose in this paper is to report four cases of mental disease occurring in patients with Paget's disease. In one, however, there was a question as to the validity of the diagnosis of osteitis deformans.

REPORT OF CASES

CASE 1.—*History.*—F. J. H., a white woman, aged 65, was admitted to the Boston Psychopathic Hospital on March 12, 1920. Her father died following a "stroke." Otherwise, the family history was essentially unimportant. The patient's early life and development were uneventful. She was married at 18 and had one child, which was stillborn. After the death of her husband, she was able to support herself by working as a saleswoman. For many years she had been under a physician's care for cardiac disease. Three years before admission she sustained a fall on the head, after which she complained of not being well. The "head tired easily." About one year later, she became careless and untidy. Although in comfortable circumstances, she complained of poverty. There were episodes of confusion. Memory became impaired. Delusions or hallucinations were not noted. She suffered from frequent dizzy and fainting spells and was taken to a general hospital. There a diagnosis of osteitis deformans, with cardiac disease and hypertension was made. On account of the mental symptoms, she was sent to the Boston Psychopathic Hospital.

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6. Marie, A.: Présentation de pièces et d'un malade aliéné atteint de maladie de Paget, Encéphale **22**:475 (June) 1927.

7. Fitz, R. H.: Certain Characteristics of Osteitis Deformans, Tr. A. Am Phys. **27**:398, 1902.

8. Watson, W. T.: A Case of Osteitis Deformans, Bull. Johns Hopkins Hosp. **9**:133, 1898.

9. Hurwitz, S. H.: Osteitis Deformans (Paget's Disease): A Report of Six Cases, Bull. Johns Hopkins Hosp. **24**:263, 1913.

10. Gillam, G. J.: Osteitis Deformans (Paget's Disease), Canad. M. A. J. **17**:60 (Jan.) 1927.

Examination.—On admission, the patient was poorly nourished and presented signs of cardiac disease. The blood pressure was 160 systolic and 80 diastolic. The skeletal system showed "marked deformity of the right lower extremities, especially of the tibia, and a great deal of exostosis. The posteropartietal and occipital bones were prominent; there was some exostosis of the distal and second phalangeal bones of both hands, with slight enlargement of the joints." Neurologic examination revealed that the pupils were unequal, the left being larger than the right; they reacted promptly to light and in accommodation. The patient was nearsighted; hearing was diminished in both ears. The deep reflexes were present but decreased. On account of the deformity, the gait was unsteady. There was marked swaying in the Romberg position.

The Wassermann reaction of the blood was negative.

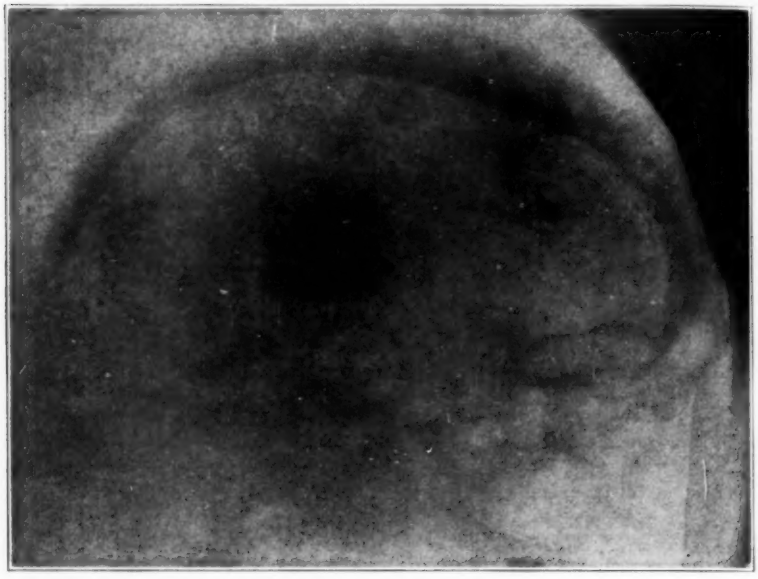

Fig. 1 (case 1).—Typical Paget's disease in skull.

The report of the roentgenologic examination by Dr. W. K. Coffin (figs. 1 and 2) read: "Typical Paget's disease (osteitis deformans) seen in the skull and in the tibia; also in the femur just above the knee joint."

The patient was quiet, cooperative, easily accessible, reminiscent and circumstantial. She was oriented for time, place and person. Memory was markedly impaired, especially for remote events. The retention of knowledge learned at school was poor. Delusions or hallucinations were not elicited. She did not have any insight into her condition; she denied that she had any deformities and insisted that her inability to walk was due only to her weakened condition.

Diagnosis.—A diagnosis of a senile psychosis, simple deteriorating type, and Paget's disease was made.

Course.—The patient's condition did not show improvement, and she was discharged on Nov. 20, 1920.

CASE 2.—*History.*—W. T., a white man, aged 52, was admitted to the Boston Psychopathic Hospital on Dec. 12, 1924. His father and one sister both died following a "shock"; otherwise the family history was unimportant. The patient was born in the United States of English stock. His early development was normal, except for peculiar fainting spells and headaches, the details of which were unknown. He abstained from alcohol and tobacco. After graduation from high

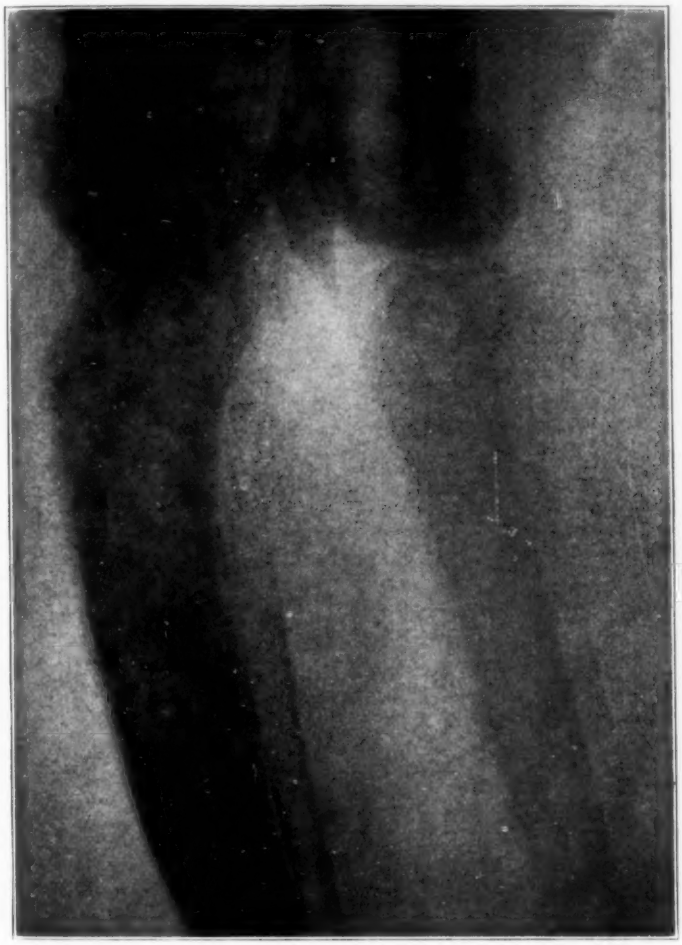

Fig. 2 (case 1).—Typical Paget's disease in tibia and just above the knee joint.

school he worked as a chemical, and later as a stock, salesman for many years. He was married and had only one child, which was born dead after a difficult labor. About four years before admission, he began to complain of vague headaches. His speech gradually became thickened and impaired so that he could not make himself understood. There was a transitory paralysis of the fingers of the right hand. One year before admission, writing became illegible. He was

unable to continue at work from soon after the onset of the illness. The admission certificate stated that his memory was gradually becoming impaired. He would walk about the streets picking up scraps and bits of metal.

Examination.—Physical examination showed a poorly developed and nourished man. The respiratory system was normal; the heart was normal; the pulse rate was 114 and regular. The blood pressure was 162 systolic, and 105 diastolic. The skeletal system showed an increase in the size of the head, which measured 22½ inches (60 cm.). There was slight bowing of the legs, but no enlargement of the tibias.

A neurologic examination showed that the pupils were irregular and reacted sluggishly to light but fairly well in accommodation. A coarse tremor of the tongue was present. The reflexes in the upper extremities were increased; the reactions in the right lower limb were brisker than in the left. There was bilateral ankle clonus. A Babinski toe reflex was present on the left side. The abdominal reflexes were sluggish. The patient was aphasic. A positive Romberg sign was noted; the patient also swayed to the left in walking. A thorough examination could not be performed because of lack of cooperation.

The report concerning the roentgen examination by Dr. W. K. Coffin, read: "Typical Paget's disease (osteitis deformans) of the skull; small sella with thick rarefied dorsum."

Laboratory Observations.—The Wassermann reaction of the blood was negative. The specific gravity of the urine was 1.026, with other tests normal. A study of the blood showed: hemoglobin, 90 per cent; white cells, 6,700; red cells, 5,186,000; polymorphonuclear neutrophils, 78 per cent; small lymphocytes, 13 per cent; large lymphocytes, 6 per cent, and transitional cells, 1 per cent.

Mental Examination.—The mental picture was one of a somewhat irritable, noncooperative man. At times he would obey simple commands, but he made frequent mistakes, such as lifting the right hand instead of the left. He was able to feed himself, but soiled himself in doing so. Apparently, there was deterioration of intellectual functions. A certain amount of stereotypy of movement was present.

Diagnosis.—The final diagnosis was psychosis with other disease of the brain and nerves; cerebral arteriosclerosis and neoplasm were considered. In view of the roentgen and clinical observations, a diagnosis of Paget's disease was also made.

Course.—The patient remained in bed and most of the time was restless and irritable. On Dec. 19, 1924, he was transferred to Westborough State Hospital. There he was quiet at first but gradually became restless, denudative and confused. The roentgenologic examination confirmed the diagnosis of Paget's disease. His condition gradually grew worse, and he died on May 14, 1925.

Autopsy was not performed.

CASE 3.—*History.*—M. C., a woman, aged 53, was admitted to the Boston Psychopathic Hospital on March 14, 1928. One sister suffered from paralysis of a leg following a "shock"; otherwise the family history was unimportant. The patient was of English stock; her early development was normal. After graduating from grammar school she worked efficiently as a saleswoman and later as buyer of perfumes in a department store. The menses were established at 14 and continued regularly until 49. She married first at 22, but divorced her husband after several years. There were several induced abortions during this marriage. About 1913, just prior to a second marriage, she noticed that she was lame; at a hospital clinic, a diagnosis of Paget's disease was made. About nine years before

admission, the patient had some difficulty with her husband and mother-in-law. At that time she felt that her husband and his mother were in league to cheat her. In 1923, the patient became suspicious that her husband was withholding part of his weekly pay. She investigated and had her suspicions confirmed; this resulted in a great deal of quarreling. She also began to feel that her husband's affection toward her had cooled since he did not have sex relations with her as often as before. She began to watch him, hired detectives to follow him and accused him of having a mistress. The patient felt that her increasing physical deformity might be the basis of his dislike for her. She related that he would run his hand over her body, and when he came to her deformed hip he would turn away in disgust. Suspicions of infidelity were gradually changed to certainties, and quarrels and recriminations resulted. She wove unrelated and incidental happenings into a delusional system. She accused him of tantalizing her sexually by beginning the sex act and not finishing. This was done because his mistress had told him to show his contempt for her. On the night of March 18, 1928, she became infuriated at this treatment and stabbed him. When arrested she poured out the story of her sexual difficulties and suspicions to the police, who sent her to the Psychopathic Hospital.

Examination.—The patient was well developed and well nourished. The heart was normal; the pulse rate was 84 and was regular. The blood pressure was 160 systolic and 100 diastolic. The lungs did not show any pathologic changes. In the skeletal system, the head showed bossing and enlargement. There was marked anterior bowing of the left tibia and of the left femur, with shortening of the limb. The right lower extremity appeared normal.

A neurologic examination revealed that the pupils were equal, regular and reacted well to light and in accommodation. The cranial nerves were normal. The abdominal reflexes were not elicited (midline scar). The gait was limping owing to shortening of the left leg. The sensory apparatus was intact. The fundi, examined by Dr. H. Goodall, showed normal disks with a small degree of sclerosis. A report of the roentgen examination (figs. 3 and 4), by Dr. W. K. Coffin, read: "The left femur, tibia and fibula, left side of the pelvis and the skull show typical lesions of Paget's disease. No very definite typical changes of Paget's disease are seen in the right femur, tibia or fibula. The femur is possibly slightly decalcified and slightly striated but not definitely pathological." A gastro-intestinal series of plates showed a long, ptosed and atonic stomach which filled poorly. Considerable spinal pressure was seen. The duodenal cap was large and well filled. The colon showed spastic constipation with a considerable twenty-four hour residue.

Mental State.—On admission the patient was excited, unstable and cried a great deal. She tried to justify her act by saying that she was driven to it in desperation. In a few days, she quieted down and became fairly cooperative and talkative. She was depressed and full of remorse. Her story contained the misinterpretations and delusions already noted. She related these with great detail and circumstantial evidence to support her assertions. She was fully oriented; her general intellectual level was fair and did not show evidence of deterioration. The memory was intact, except that she claimed an amnesia for the actual assault. There was no insight and judgment was poor.

Laboratory Observations.—The Wassermann reaction of the blood was doubtfully positive on one occasion; subsequent tests showed a definitely negative reaction. The Wassermann reaction of the spinal fluid was negative; no cells were present in the fluid; the colloidal gold test was negative; the total protein was 21 and the sugar, 65. The specific gravity of the urine was 1.033, and there

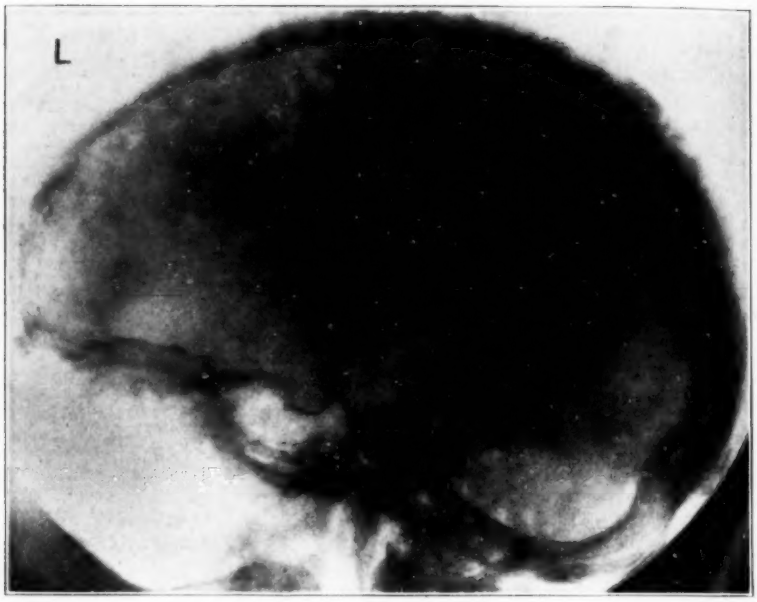

Fig. 3 (case 3).—Typical lesions of Paget's disease in skull.

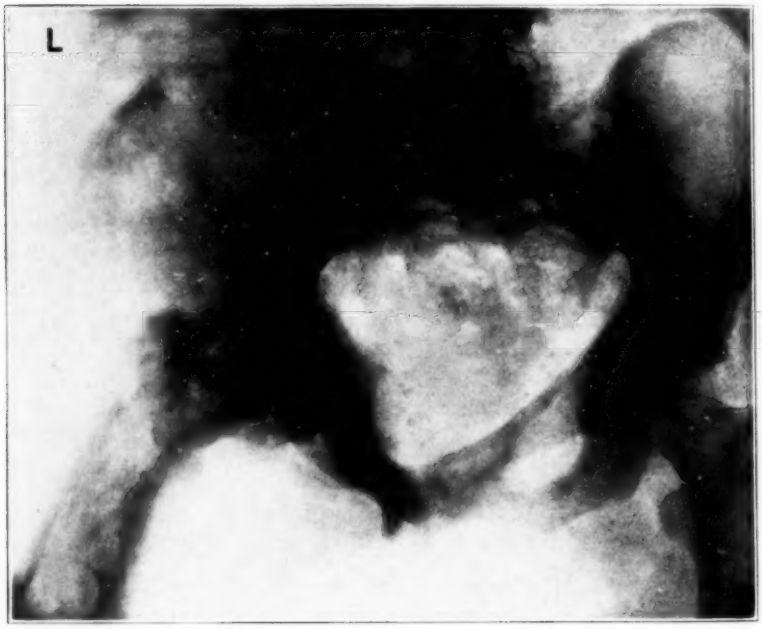

Fig. 4 (case 3).—Typical lesions of Paget's disease in left femur, tibia and fibula and left side of the pelvis.

was a slight trace of albumin. The blood nonprotein nitrogen was 37.5 and the blood sugar, 85. The blood counts made on different days are shown in the accompanying table.

Diagnosis.—A diagnosis of a paranoid condition and Paget's disease was made.

Course.—The patient developed phlebitis in the left leg and an infarct in the base of the right lung from which she made an uneventful recovery. She persisted in her beliefs and suspicions. When told of her husband's death from pneumonia, she took the news calmly. She remained quiet and cooperative and did not show abnormal behavior.

CASE 4.—*History.*—N. B., a woman, aged 46, was admitted to the Boston Psychopathic Hospital on Nov. 8, 1920. The maternal grandfather and mother died from cancer. The father died from "hardening of the arteries" and an uncle had "softening of the brain, was foolish and lost his mind." The patient had an uneventful early development. She was described as pleasant, sociable and stable. She married at 23 and bore three children. She had hay-fever for many years, and since childhood had had cyanosis of the hands and feet. Six years before admission she suddenly became unable to speak for several hours, although she knew what she wanted to say. Paralysis or headache was not present at the time. Three

Blood Counts on Different Days

White cells	13,700	9,100	8,400
Hemoglobin (Sahli)	114	85	85
Red cells	4,670,000	5,140,000	5,200,000
Polymorphonuclear neutrophils	56	57	57
Small lymphocytes	19	20	29
Large lymphocytes	21	14	9
Transitional cells	4	3	3
Eosinophils	0	3	1
Basophils	0	2	2
Platelets	Normal	Normal	Normal
Lymphoblasts	0	1	0

and a half years later, her face became drawn to one side, and speech was thickened. This cleared up, but the patient was not able to write. She gradually began to lose interest in things, and became untidy and careless about her personal appearance. At times, she apparently realized the loss of interest but did not care.

In February, 1919, she was operated on for cancer of the right breast.

On Sept. 9, 1920, she suddenly stated that she was blind, sight returning during the night. The patient complained of continuous frontal headache and frequent dizzy spells. She could sleep only when under the influence of opiates.

On September 28, she was taken to a hospital, which she thought was her new apartment. She carried on a conversation with her absent daughter as if she were present. Roentgen examination showed a thickening of the bones of the skull. Memory was poor, and she slept a great deal.

Examination.—On admission to the hospital, she showed a left central facial weakness, paralysis of the left arm and paresis of the left leg. The Babinski sign and clonus were not present. Diminution of sensation to pin prick was present on the left side.

The report of the roentgen examination by Dr. Coffin (fig. 5), read: "Skull very thick and dense generally. Islands of increased density in parietals seen. Somewhat suggestive of Paget's disease. The sella is not much, if at all, enlarged. All its components are dense with definite evidence of erosion. Meningeal vessel markings are more prominent than usual and possibly indicate slight increase in intracranial pressure."

Mental State.—The patient was somewhat stuporous but was easily aroused; she was moderately cooperative and accessible. Emotionally she was dulled. She thought her son was present and kept calling to him. She was disoriented for time and place. The memory was markedly impaired in both remote and recent fields. Her statements were contradictory and confused. Her insight was poor.

Diagnosis.—A diagnosis of psychosis with tumor of the brain was made.

Course.—The patient was transferred to the Peter Bent Brigham Hospital where she showed hemiparesis of the left side, choked disk and marked mental symptoms. On November 17, a carcinoma, thought to be metastatic, was removed from the right cerebral hemisphere. The patient died on Jan. 20, 1921.

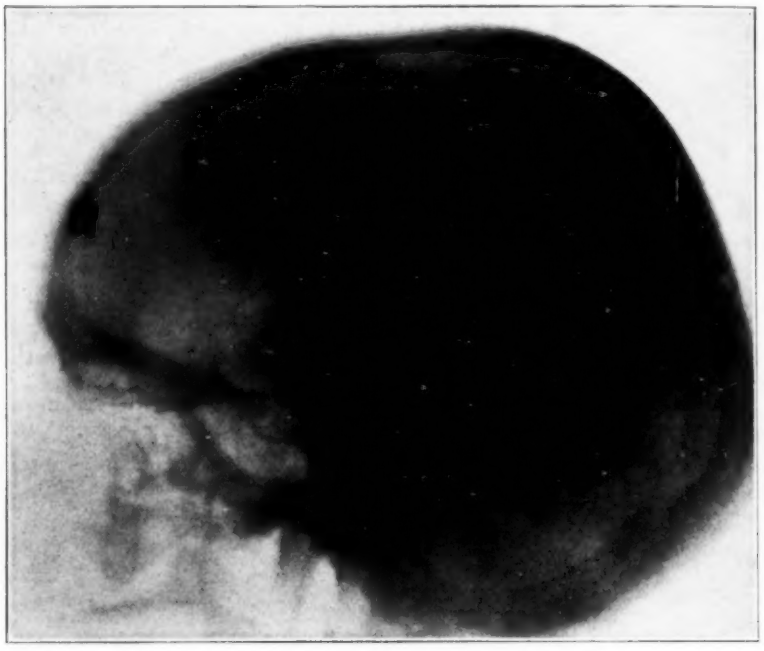

Fig. 5 (case 4).—Thick, dense skull, with islands of increased density in parietals seen, somewhat suggestive of Paget's disease.

COMMENT

It is interesting that three of the cases reported showed definite involvement of the central nervous system with neurologic signs. Cases 1 and 2, both undoubted Paget's disease, presented the mental symptoms associated with organic disease of the brain.

The symptomatology in case 4 might be attributed solely to the neoplasm. The diagnosis of osteitis deformans in this case is questionable. On rereading the plates, Dr. Coffin thought there was a possibility that the condition might be due to metastases. Carcinoma and

sarcoma, however, are often associated with Paget's disease, as has been brought out by Watson,[8] Bird [11] and others.

In view of the etiologic significance attached to syphilis by A. Marie,[12] Barré and Specklin [13] and other writers, it is noteworthy that only in one of the patients (case 3) was the possibility of this infection considered.

The pituitary gland was apparently not incriminated, although two cases showed changes in the sella turcica. One is inclined to think that any disorder of this gland in osteitis deformans is secondary to the bony changes and is not etiologically relevant.

The study of the blood cells in case 3 revealed a slight increase in the basophils to 2 per cent of the total count; the eosinophils were within normal limits and did not show the increase observed by Piney and Moynan. This patient also presented a unilateral distribution of the bony changes, which, according to Hurwitz,[9] is not very rare.

Significant, although perhaps not to be stressed on account of the small number of cases, is the fact that in the ancestry of each patient there was a history of "shock" or other arterial disease of the brain. It would be merely speculative to postulate an inherent factor, perhaps metabolic, which attacks the arterial system in the ascendants and the bony structure in descendants. Case 4 showed in addition a definite carcinomatous strain.

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11. Bird, C. E.: Sarcoma Complicating Paget's Disease of Bone, Arch. Surg. **14**:1187 (June) 1927.

12. Marie, A.: À propos de la maladie de Paget, Bull et mém. Soc. méd. d. Hôp. de Paris **18**:1417, 1924.

13. Barré, J. A., and Specklin, P.: Anosmie, ageusie et troubles faciocochleovestibulaires, expression d'une maladie de Paget cranienne; réaction de Bordet-Wassermann positive dans le sang, Rev. neurol. **1**:97 (Jan.) 1925.

THE DIENCEPHALIC VEGETATIVE MECHANISMS

THE ANATOMY AND PHYSIOLOGY *

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NEW YORK

THE WISDOM OF THE BODY

It is not my intention to attempt in any way a complete summary of the anatomy or the physiology of the upper central vegetative mechanics. In the first place, I disclaim any mastery of a subject which in the last ten years has become an important issue in many of the cardinal problems of internal medicine; to present even an adequate summary of these would occupy several hours, if not days.

Apart from accident, parasitic skin diseases and a few minor medical problems, I might say, exaggeratedly I admit, that the vegetative centers of the medulla oblongata, midbrain and 'tween-brain hold most of the secrets of that "wisdom of the body" which lies behind the vis medicatrix naturae on which physicians have always relied, even while they have had some illusions, if not delusions, that they were important agents in therapy.

In that most ancient collection of "wisecracks" one reads that "the law of God is in the Heart";[1] "A man's heart deviseth his way,"[2] and "As a man thinketh in his heart, so is he"—in all of which, as prelogical types of thinking, may it not be said that the vegetative nervous system (parasympathetic) was recognized even in those early days as playing a major rôle in man's behavior, metabolic as well as social?

One also finds indications that the "sympathetic" aspect of the vegetative nervous system had not escaped the attention of the ancients, for does one not read of the "bowels of compassion," of man's "spleen" and his related "choler," and of "hypochondria." The story of Job is of more than mere historical interest. Here again I shall desist from giving any full catalog of the wisdom of the ancients, and content myself with saying that "religion" as an expression of experience is not to be too lightly considered.

In 1921, in a paper termed a "Neuropsychiatric Pilgrimage,"[3] I recounted some of my efforts at reestablishing contacts with European

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* Presented as an illustrated introduction to a symposium on the Vegetative Nervous System and Internal Medicine at a meeting of the New York Academy of Medicine, Section on Neurology and Psychiatry, Feb. 14, 1928.

1. Psalms 37:31.

2. Proverbs 16:9.

3. Jelliffe, S. E.: Studies in Psychiatry, Nervous and Mental Disease Monograph Series, vol. 2, no. 41, 1925.

neuropsychiatry. Among these I called attention to some of the newer work that was being carried on in Erlangen and in Berlin clinics on anatomic and physiologic studies on the vegetative nervous system. I then spoke of certain pathways and synapses in relation to problems of internal medicine, as seen from the angle of the vegetative nervous system, in contrast to reigning humoralistic dogmas still being adhered

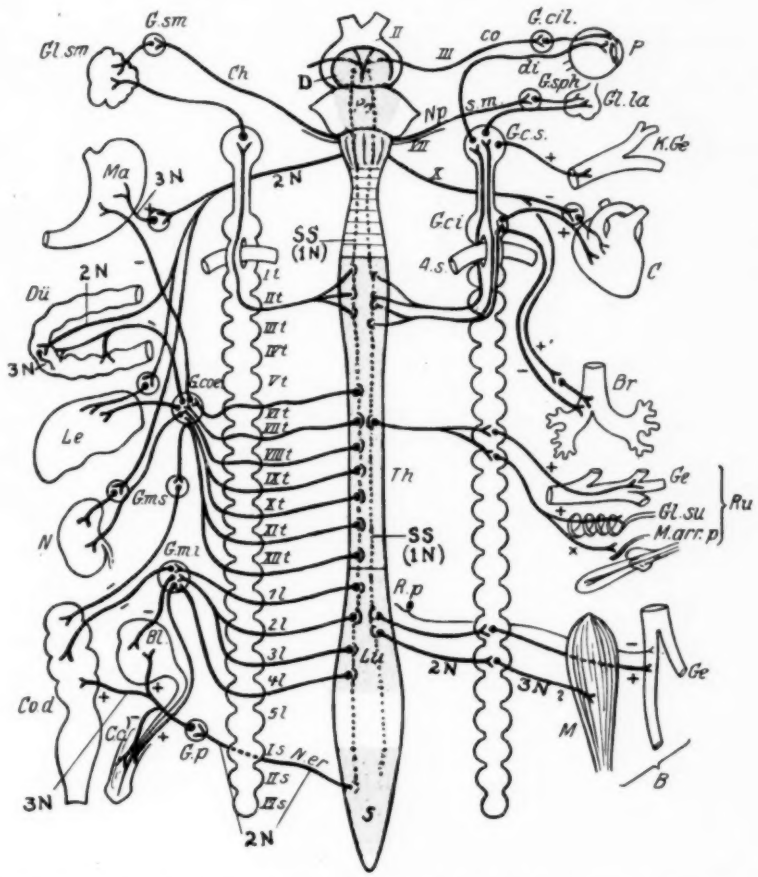

Fig. 1.—General schematic representation of vegetative nervous system, peripheral portion.

to. At that time, I reviewed briefly some of the work of L. R. Müller [4] (a brother of Friedrich Müller of Munich who has recently visited this country), and laid particular emphasis on the activities of Lewy, with

4. Müller, L. R.: Die Lebensnerven, Berlin, Julius Springer, 1924. Müller and Greving: Ueber den Aufbau und die Leistungen des Zwischenhirns und über seine Erkrankungen, Med. Klin. **21**:569, 1925.

Brugsch and Dresel,[5] in their attack on the neurology of metabolism, in which the importance of mesencephalic and diencephalic structures was accentuated. This had been near to my interest, and frequently has been referred to in the discussions in the section on neurology and psychiatry of the New York Academy of Medicine and in the New York Neurological Society, since Wilson, in 1911, erected his picture of lenticular degeneration and its correlated liver disease.

THE VEGETATIVE SYSTEM

I wish I could again show the slides I then had prepared of some of the experiments made on lower animals in which mesencephalic and diencephalic structures were wounded. Metabolic studies and histopathologic control research showed the importance of wounds of the dorsal vagal vegetative synapses with reproduction of the Claude Bernard sugar phenomena. Retrograde degenerations were traceable to the nucleus periventricularis (de Lange) and the ganglion habenulae of the diencephalon.

These were but the beginnings of what has now become an enormous mass of information relative to a host of situations in internal medicine, related to the activities of the vegetative nervous system.

I cannot refrain from accenting the sympathetic interest taken by Walter Kraus in these studies. It was he who, in 1917, first translated Eppinger and Hess'[6] most fascinating article on "Vagotonia," a pioneer work in this field; and he who, in 1919, in his masterly translation of the work of Higier,[7] gave to the English reader the first important monograph on "Vegetative Neurology."

Much as I would like to review here something of what American neurology has contributed to the study of the vegetative nervous system I must be content to say that I have done this in my "Fifty Years of American Neurology," published in the semicentennial volume of the

5. Dresel and Lewy: Die zentrale Veränderungen beim Diabetes mellitus und die Pathophysiologie der Zuckerregulation, Berl. klin. Wchnschr., 1921, no. 27, p. 739; Die Zuckerregulation bei Paralysis agitans Kranken, Ztschr. f. d. ges. exper. Med. **26**:95, 1921. Dresel: Erkrankungen des vegetativen Nervensystems, Handbuch der speziellen Pathologie und Therapie, **10**:3, 1922; numerous other papers; Experimentelle Untersuchungen zur Anatomie und Physiologie des peripheren und zentralen Nervensystems, Ztschr. f. d. ges. exper. Med. **37**:374, 1923. Dresel calls attention to the fact that Greving speaks of the nucleus paraventricularis rather than the nucleus periventricularis, in referring to these experiments.

6. Eppinger and Hess: Vagotonia, Nervous and Mental Disease Monograph Series, no. 20, Washington, D. C., Nervous and Mental Disease Publishing Company, 1917.

7. Higier: Vegetative Neurology, Nervous and Mental Disease Monograph Series, no. 27, Washington, D. C., Nervous and Mental Disease Publishing Company, 1919.

American Neurological Association in 1924. I will, however, quote one sentence [8] from this summary:

> At all events we now see vegetative neurology, the master of the most important problems of internal medicine—still too loath to be followed by the internists, excepting Pottenger, in spite of the early example set by Eulenburg and Guttmann (1873) and Giovanni (1876) and documented in recent years by the monographs of Gaskell, Higier, L. R. Müller, Eppinger and Hess, Guillaume, Pende, Langley, Ranson, Herrick, Laignel-Lavastine, Dresel and others.

In this presentation I shall lean heavily on my European confrères, since they have systematized the situation better than any others. I

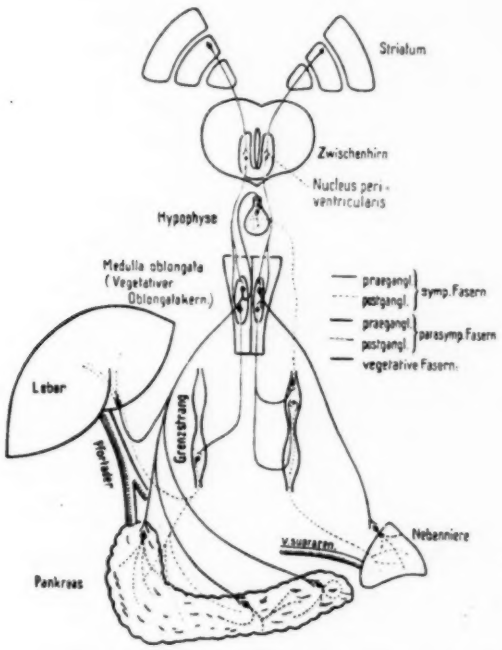

Fig. 2.—Pathways involved in sugar metabolism (Heyer, in Hirsch: Handbuch der innere Sekretion).

am not unmindful of Tilney's significant contributions, or of those of Herrick, Ranson, Huber, Kuntz and the American school of comparative neurologists, second to none in the neurologic world.

There is little question at present that the main coordinating mechanisms for the vital functions of the entire body lie within the diencephalic and related vegetative synaptic centers. An aeroplane photograph of the epidemic encephalitis cases shows this most strikingly. Here one sees seborrhea for the skin specialist; glycosuria for the

8. Jelliffe, S. E.: Fifty Years of American Neurology, Tr. Am. Neurol. A., 1924, p. 413.

"diabetic" fan; liver, kidney, endocrine, lung, thermal regulation and what not. Each and every possible problem for the internist can be detected in this photograph, as seen from the aeroplane.

Coming closer into the laboratory, one perceives, in this same encephalitis frame, alterations in general metabolism, changes in the salt and water content, changes in the composition of the blood, modifications of osmotic cellular pressure and variations in blood pressure—also, perturbations in sleep and in waking, the muscular tone, uterine contractions, bladder and intestinal function, pupillary reactions, sweating, vascular alterations, bodily temperature, calcium-potassium balance, hormone production and all the humoral regulations. This entire series of phenomena as seen in the epidemic encephalitis of Cruchet and von Economo (1917) is related largely to diencephalic lesions, and will require the plotting of the vegetative neural anatomy before the precise mechanisms of their production can be understood. Müller and Greving have drawn up the following interesting tabulation of some of the more outstanding of these vegetative disorders seen in encephalitis cases. These are but fragments of a much richer symptomatology which is being reported on from all quarters of the medical world.

Phenomena	*Structural Involvement*
Pathologic sleep states	Involvement of posterior portion of third ventricle and the central gray of the diencephalon
Irregularity of the pupils; pupillary stasis	Irritation or destruction of the visceral oculomotor nucleus in central gray of diencephalon
Ptosis, strabismus, eye muscle palsies, nystagmus	Destruction, irritation of the oculomotor nuclei regulating the striped musculature of the eye in floor of fourth ventricle
Salivation	Irritation or destruction of visceral centers in hypothalamus, governing secretion of salivary glands
Greasy face	Irritation or destruction of secretory centers of fat glands of face located in neighborhood of globus pallidus
Hyperhidrosis tendencies	Disturbance of centers for sweat secretion in hypothalamus
Bladder disturbances	Disturbances of bladder centers in hypothalamus
Adiposity	Disorder of metabolic centers in tuber cinereum

VEGETATIVE RECEPTORS AND DIENCEPHALIC SYNAPSES

It is here necessary only briefly to suggest how great is the ignorance of the physician regarding the peripheral vegetative system, and at the same time to indicate how much there is yet to be learned.

More is known of the efferent pathways of the vegetative reflex arc than of the afferent ones. In fact, for many years, the dogma ran, chiefly supported by the weight of Langley's teachings, that there was no specific vegetative afferent part of the vegetative reflex arc; the general somatic sensory system was thought to function here solely. This is, I believe, definitely disproved, and vegetative receptors and afferent vegetative fibers are now well known histologically for practically every organ of the body.

It may also be touched on, in passing, that probably many, if not most, receptors are pluripotential. They react to different energy modalities. They function for vegetative (life) and also for sensory (gnostic) purposes. Thus, Dr. White and I[9] have said that, as a paradigm, the optic receptors may be considered in this pluripotential sense: 1. They receive photic energy stimuli which may simply be called "motion." There are a host of these—below red and above violet; and maybe Milliken's rays can be included, which possibly involve other than the optical photoreceptors. These never become gnostic, i.e., conscious, but they do operate for the metabolism of the tracts themselves, metabolism in general and for what else no one yet knows. The numerous studies of the action of light on vitamines, etc., belong in this category.

2. They receive energy stimuli of varying intensities, which gnostically are known as the colors of the spectrum. With what unconscious reactions to color there may be, I am not here concerned.

3. They receive "Gestalt," "configurations," which are called "leaves," "houses," "people," etc. It is fairly well surmised that at various synapses of the optical pathways, important behavioristic reactions may arise, with vegetative implications. Thus are found the phenomena of so-called "geniculate vision," etc., into which entrance also cannot be made (Brouwer et al.).

4. Finally, there stream in through these receptors stimuli, which, associated and correlated with others, are called judgment values and are spoken of as "poisonous blue berries of pulsatilla"; "savory red berries of the raspberry"; "the joyous sunrise of spring," or the "depression of the late fall landscape." These gnostic associations or "Gestalt" perceptions also come in through this pluripotential receptor, either as a whole or as of later compounded functioning. At what stations in the pathways these compoundings take place, it is not here necessary to outline. Those who are neurologically and psychiatrically interested can enjoy Kappers' and Winkler's discussion of these switchboard connections. What is here suggested as to high grade pluripotential groups of receptors, such as those of the retina or of the

9. Jelliffe and White: Diseases of the Nervous System, ed. 5, Philadelphia, Lea & Febiger, 1929, and previous editions.

vestibulo-auditory groups, are presumably present in other receptors of the body. I mention the suggestion for what it is worth, in the general mechanistic conception of the human organism as an energy transformer. Von Monakow and Mourgue in their "Biological Introduction to Neurology and Psychopathology" show an even more complex compounding of these receptor-connector possibilities.

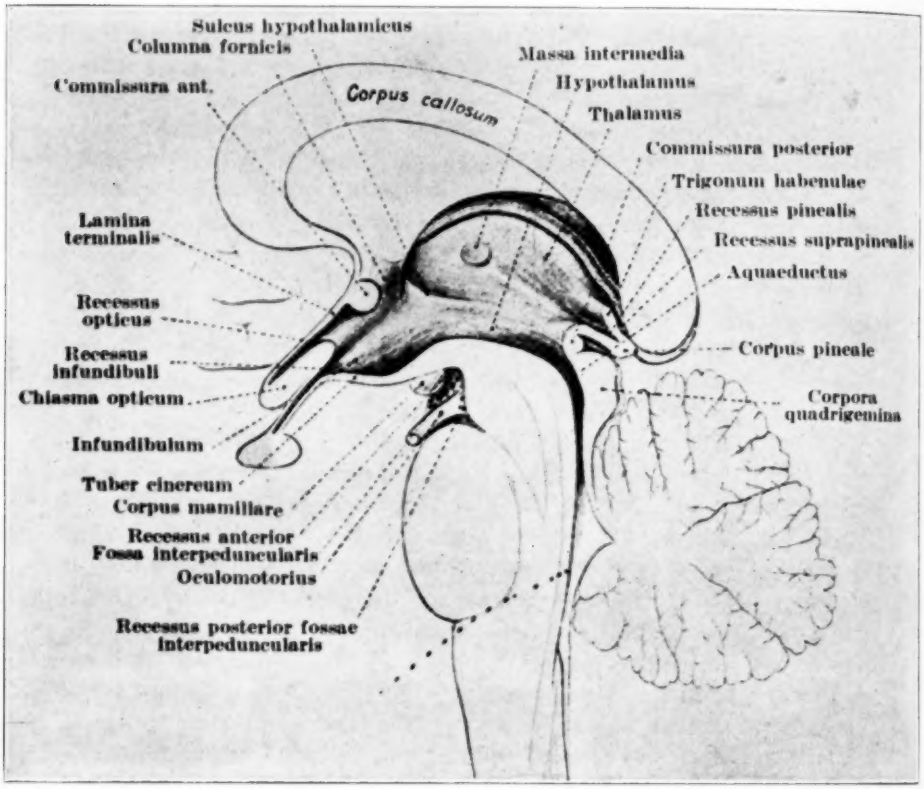

Fig. 3.—Sagittal section showing chiefly the adult diencephalic structures, the optic chiasm, infundibulum, hypophysis, tuber cinereum, corpus mammillare, thalamus, hypothalamus, pineal body, corpora quadrigemina (Müller Die Lebensnerven, Berlin, Julius Springer, 1924).

I can, however, here speak only of certain central groupings the functions of which have been under discussion in the past ten years.

In looking at a general scheme for orientation, the field of inquiry lies from the optic chiasm back to the walls of the third ventricle (the central gray of the older anatomists), which is now being interestingly differentiated. It represents an amalgam of older vegetative functioning groups (Winkler, Kappers, Cajal and Herrick).

Viewed sagitally the diencephalon begins at the optic chiasm. Posteriorly one sees the tuber cinereum, the corpora mammillaria and the subthalamic region in general. Here, attention will be called to certain vegetative nuclei, or synapses, the importance of which, as parts of the reflex arc of the living regulation, is now being actively studied by

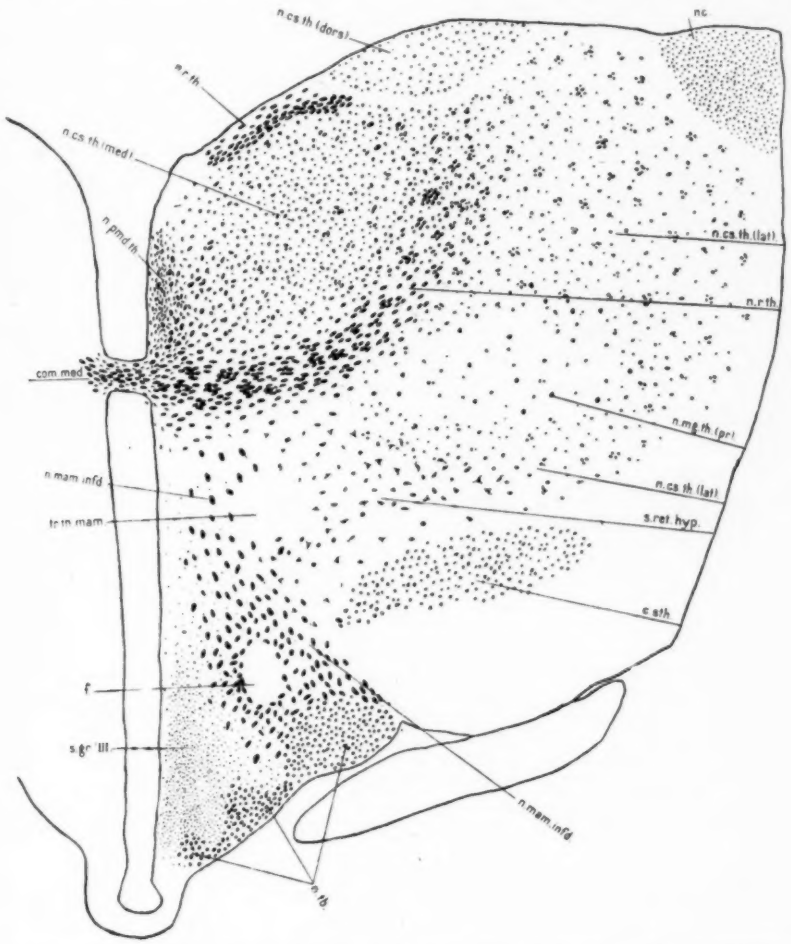

Fig. 4.—Frontal section of human diencephalon at level of tuber cinereum: *n. tb.*, showing three nuclei. Other nuclei are: *s. gr. III*, substantia grisea of third ventricle; *n. mam. infd.*, nucleus mammilaris infundibularis; *c. sth.*, corpus subthalamicus; *s. ret. hyp.*, substantia reticularis hypothalamici; *n. r. th.*, nuclei reunientes (Malone).

experimental and by pathologic methods. It may be of interest nationalistically that an American investigator, Malone, working in Jacobsohn's laboratory in Berlin (1910), first definitely recognized the functional

character of most of these cell groups and described and named many of them.

Those cellular masses seen cephalad are the nucleus supra-opticus, which phylogenetically is an old structure (Rothig), a group of nuclei of the tuber cinereum, and nuclear masses (substantia grisea) of the central gray about the walls of the third ventricle, namely, the nucleus pallido-infundibularis, nucleus mammillo-infundibularis (nucleus infun-

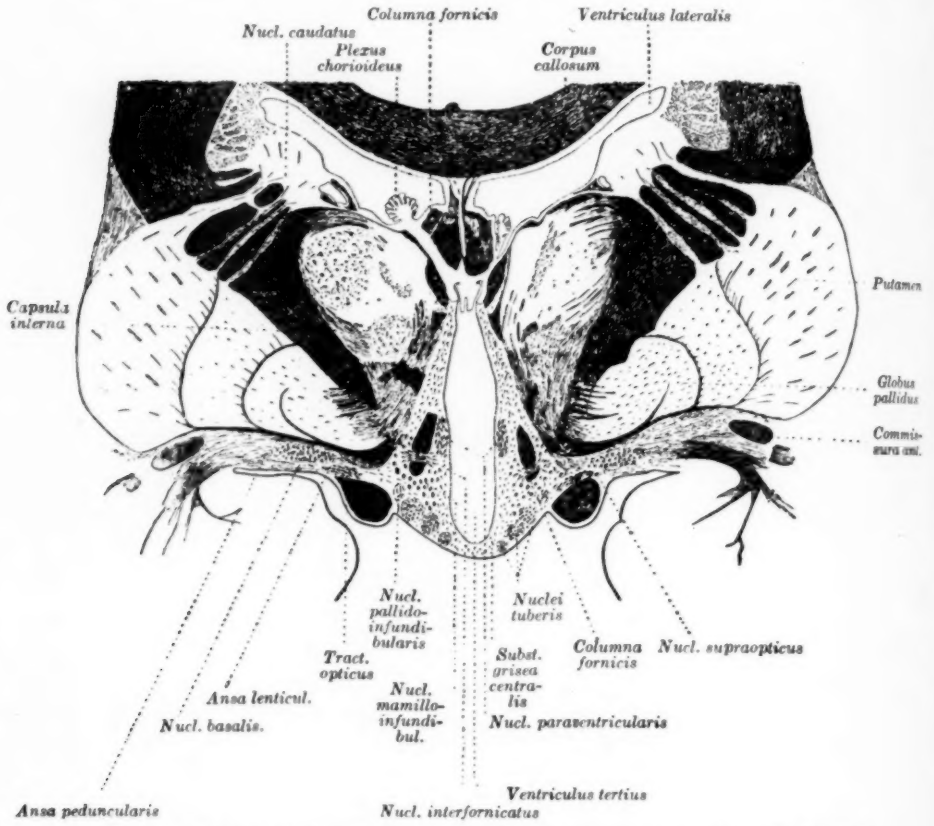

Fig. 5.—Frontal section through the tuber cinereum with schematically indicated cell groups in the hypothalamic region and the walls of the third ventricle (Greving). Comparison should be made with the figures of Foix and Nicolesco.

dibularis inferior of Winkler and Potter), nucleus paraventricularis and nucleus interfornicatus. These are here illustrated in a frontal section taken from Greving.

Within the corpora mammillaria, Greving designated, instead of the older terms, median and lateral ganglia, a nucleus magnocellularis, a nucleus parvocellularis and a nucleus mammillaris cinereus. Lateral to these, Malone described a nucleus intercalatus.

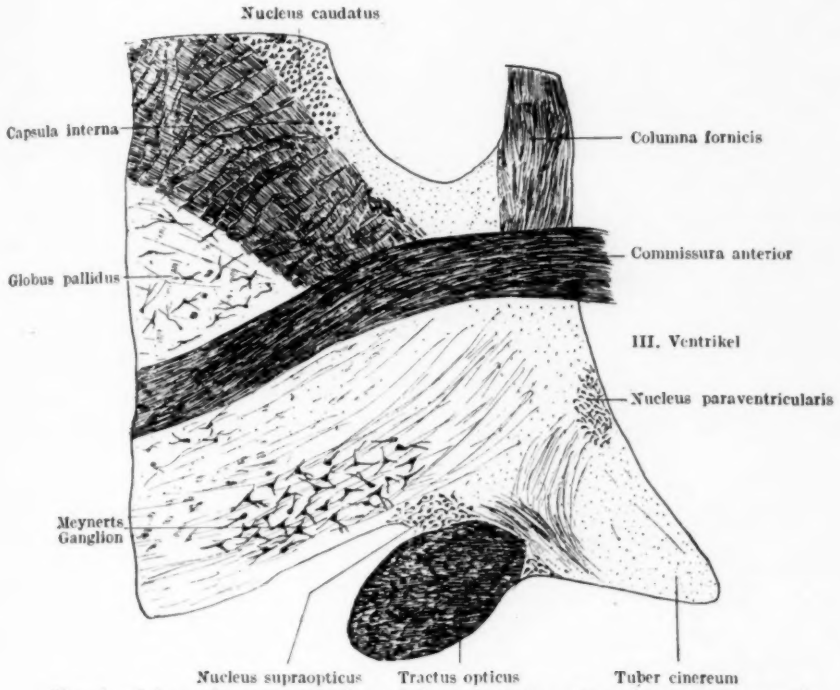

Fig. 6.—Schematic representation of frontal section through anterior commissure and tuber cinereum at the beginning of the diencephalon (Greving).

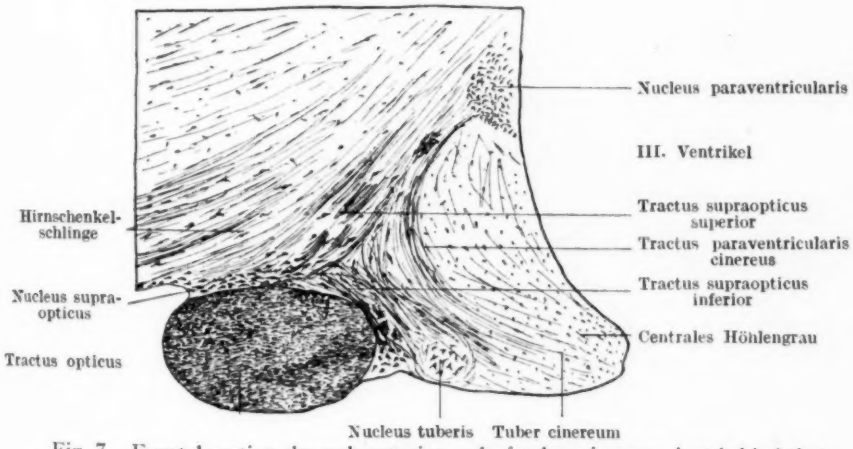

Fig. 7.—Frontal section through anterior end of tuber cinereum just behind that of section shown in figure 6 (Greving).

Further caudad in the subthalamic region, the corpus subthalamicus (corpus luysii) is an outstanding structure. In addition to these, Malone also described a cell area as substantia reticularis hypothalamici lying between the pes pedunculi and the corpus mammillaris. Winkler and Potter (according to Morgan [10]) called this the nucleus hypothalamicus

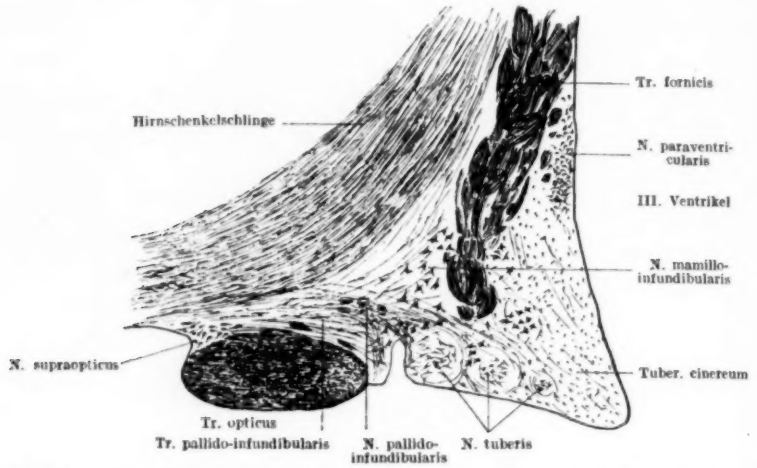

Fig. 8.—Frontal section of mid-area of tuber cinereum, caudad to last section (Greving).

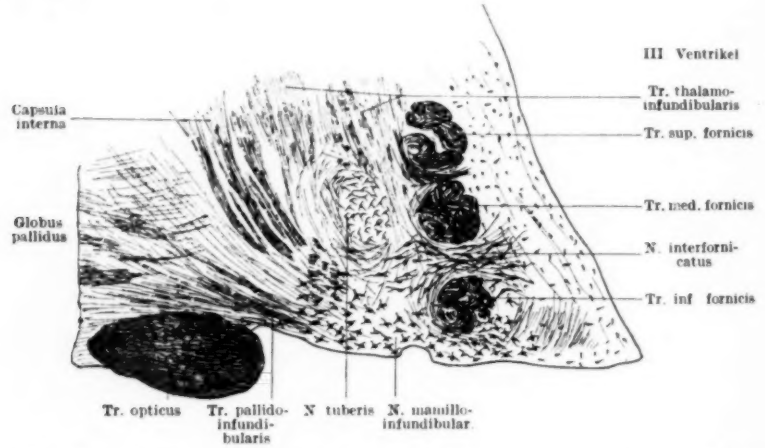

Fig. 9.—Frontal section of diencephalon, caudal end of tuber cinereum (Greving).

lateralis (*h. l.*). Cajal spoke of it as the nucleus interstitialis of Forel's field (Vogt, the nucleus campi Foreli).

Around the walls of the third ventricle are found a number of small cells which, by reason of their histologic characteristics, Malone claimed

10. Morgan, L. O.: The Corpus Striatum, Arch. Neurol. & Psychiat. **18**:495 (Oct.) 1927.

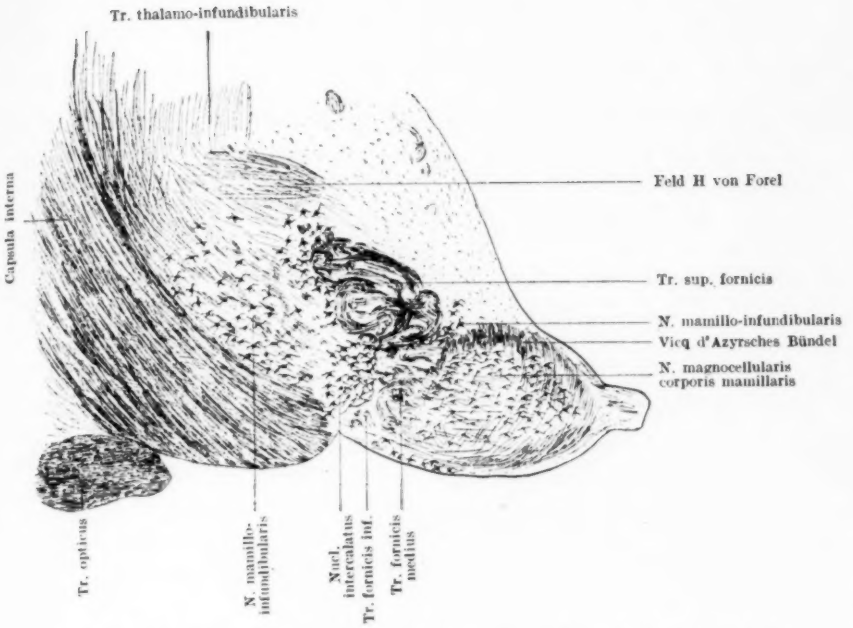

Fig. 10.—Frontal section of caudal region of mammillary bodies (Greving).

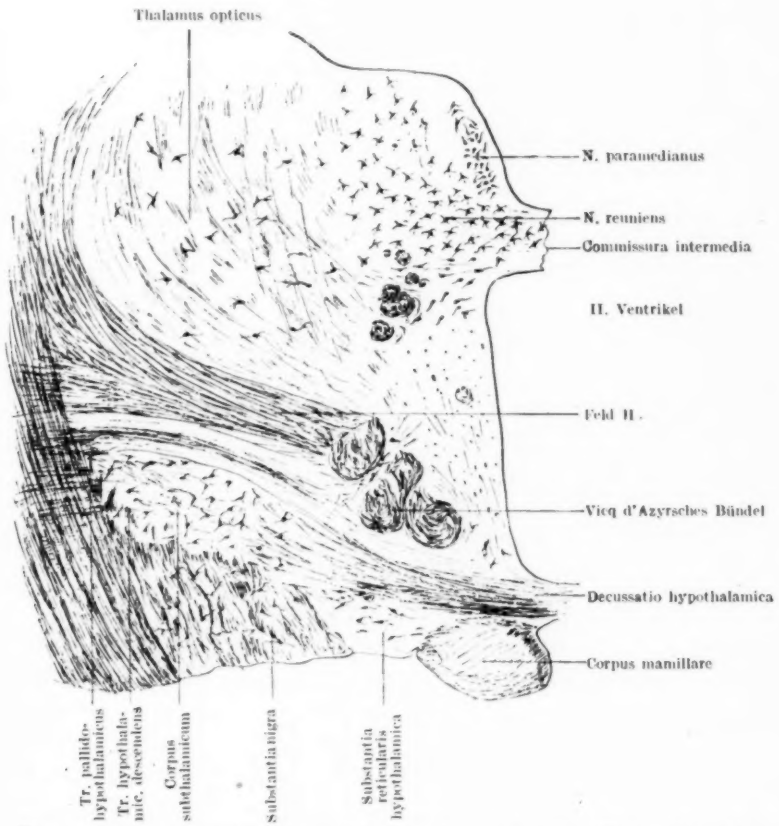

Fig. 11.—Frontal section of caudal end of corpus mammillare. Commissura intermedia and corpus luysii (Greving).

belong to the vegetative system. One grouping of special importance and prominence he called the nucleus paraventricularis. Malone also described two other groups lying further caudad, namely, the nucleus reuniens and the nucleus paramedianus.

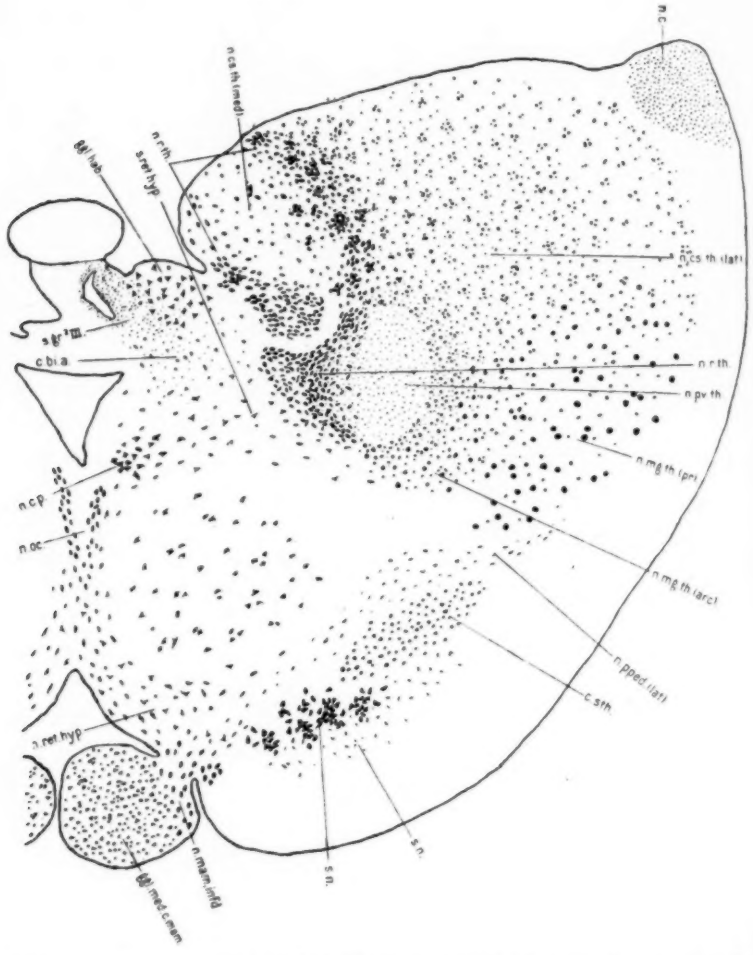

Fig. 12.—Malone's study (Nissl stain) of nuclei of diencephalon at mid-level of corpora mamillaria. (Lettering as in figure 4.)

It is not my purpose to go into any discussion of other diencephalic structures, notably the enormously complex thalamic groups, the habenulae, the epithalami (pineal bodies) or other paleothalamic or neothalamic nuclei.

So far as histologic structure affords any clue as to differentiation of function, I have picked out those nuclei which, according to the

studies of Malone, Greving and others, are conceived to be parts of the vegetative reflex arc, although, as pointed out, belief in receptor pluripotentiality makes the distinction between vegetative, or splanchnic, elements and somatic sensory elements largely artificial.

Nor is one yet prepared to say that exact localization is attainable, and, still further, what parts of these synapses represent only links

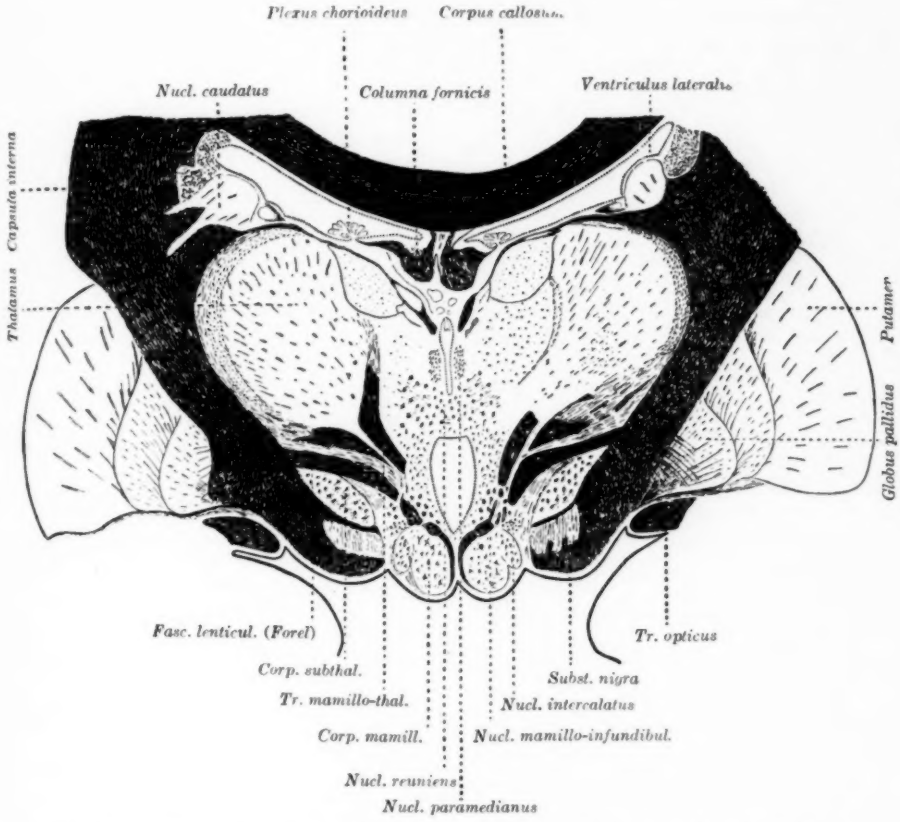

Fig. 13.—Frontal section through the corpora mamillaria with schematically indicated cell groups in the hypothalamus and in the walls of the third ventricle (Greving). Comparison should be made with the figures of Foix and Nicolesco.

still on the sensory intake side, or are the earlier representatives of the motor transformers on the way to effectors. Whether they lie directly, in part, on the sensory intake line, indirectly through thalamic relays or still more indirectly through thalamostriatal motor relays I cannot discuss fully. At all events, there is evidence, phyletically speaking, that in those parts of the hypothalamus, with which I am here concerned, some of the cells serve as reception and coordinating stations for tertiary

olfactory and gustatory neurons, and other cells within compound nuclei also function as beginning centers for efferent vegetative pathways (Kappers).

Following Greving, on the basis of phylogenetic persistence of the cellular masses under consideration at present, vegetative functions may be said to be definitely established for: (1) the substantia grisea centralis; (2) nucleus mammillaris cinereus; (3) nucleus interfornicatus; (4) nucleus paramedianus; (5) nucleus supra-opticus, and (6) nucleus paraventricularis.

If, for instance, it is established on the basis of animal experimental evidence that lesions of the nuclei of the tuber cinerea—some of whose cells are direct on the olfactory sensory intake—can bring about direct changes in thermal regulation (Aronson, Sachs) in water and salt diuresis, then some of its cells probably function motorially in the metabolic or vital vegetative processes. Hence, one has, presumably, a highly compounded nucleus; similarly one has the growing mass of evidence, still filled with thorny problems for explanation, that lesions in the corpus subthalamicus can cause vasomotor spasms, modification of the pupils, sweating and contraction of the bladder—and, hence, have motor synaptic functions.

This most intricate problem when an afferent impulse is switched to an efferent one I cannot here enter into. In a minute and painstaking series of investigations, Morgan showed how difficult it is to come to definite conclusions relative to this problem, especially as it concerns the synapses in the corpus striatum. The afferent connections here, as already indicated for the whole of the peripheral vegetative systems, remain hazy. It is of little significance to emphasize these difficulties, since I am trying to offer some more or less practical conclusions as to the functional values of the mechanisms related to the luysian nucleus, the nucleus mammilio-infundibularis, the substantia reticularis hypothalamici, the interpeduncular nucleus and the interstitial nucleus. Morgan included the nucleus of Darkschewitch, not mentioned here.

I have spoken specifically of the nucleus reuniens of Malone. According to Wallenberg, van Gehuchten and Winkler, this nucleus is a station in the trigeminal thalamic fasciculus. Morgan left this situation to be resolved by further study. I can only perhaps dodge the issue, as most authors seem to, by saying that many of the nuclei are bound up with the striatum and thus the effector impulses get under way, or, as Greving puts it: "From my own anatomical findings I believe I can bring some evidence to show that the corpus striatum enters into the regulation mechanisms of the vegetative centers in the midbrain."

RECONSTRUCTIONS OF FIBER CONNECTIONS

Having briefly reviewed the anatomic substratum, so far as the nuclear masses are concerned, I shall close with a brief presentation of some of the reconstructions of the fiber connections in this most difficult field.

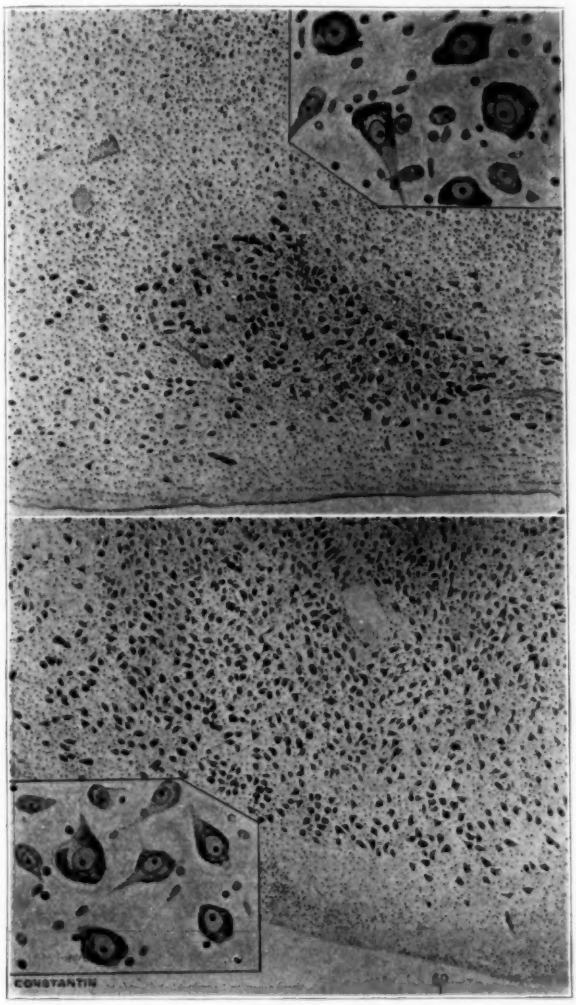

Fig. 14.—Nucleus periventricularis and nuclei tuberis (Foix and Nicolesco).

First, I will present a general schematic representation of the older recognized fiber pathways of the diencephalon, as already made known, chiefly by the researches of Edinger and Wallenberg. Olfactory stimuli come in large numbers over the basal Riechbundel of Wallenberg to

reach synapses in the corpora mammillaria—some reach the interpeduncular nuclei. As low down as the cyclostomes, an efferent pathway—the tractus mammillopeduncularis (Kappers [11])—serves as a coordinating efferent path to vegetative motor centers of the medulla. The diencephalon in these animals is primarily a nutritional coordinating center, the mesencephalon serving as a somatic motor correlation region.

It is well known that a gradual replacement of the older olfactory and gustatory activities of lower animals by optic and auditory stimuli has taken place for gnostic purposes. Conscious control of automatic unconscious actions has been the program accompanying the develop-

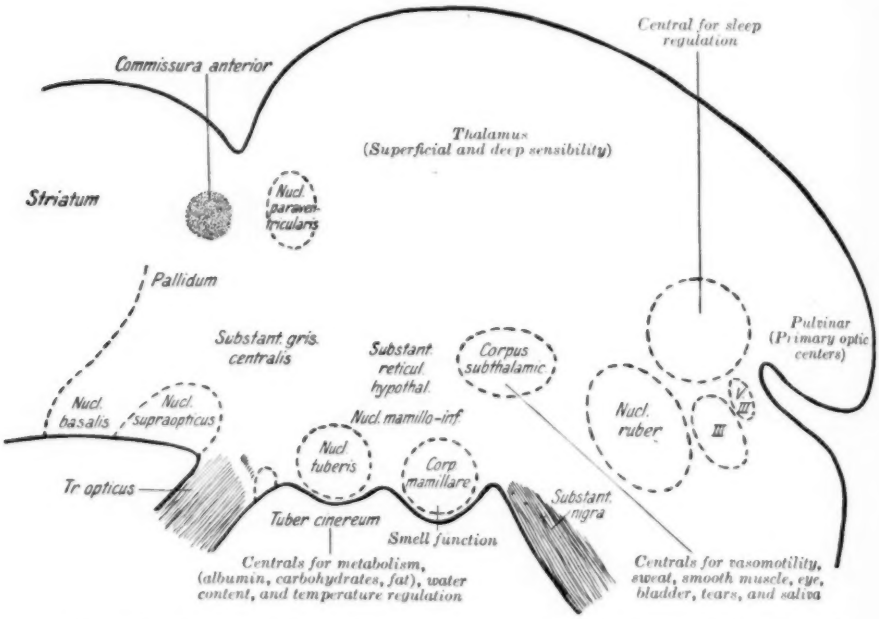

Fig. 15.—Schematic representation of the vegetative cell groups in the interbrain and their function (sagittal section, Greving).

ment of the human cortex, now represented by at least 60,000,000 cortical switchboard connections.

Comparative anatomists stress the fact of the involution of the olfactory and gustatory synapses in the tuber cinereum and the corpora mammillaria and other diencephalic nuclei. They deduce some conclusions that these functions have become more or less abrogated; yet I hazard the opinion, in spite of the bloodhound's capacity to follow a scent or the fox-dog's ability to chase an anise bag, that no bloodhound,

11. Kappers, C. U. A.: Die vergleichende Anatomie des Nervensystems der Wirbeltiere und des Menschen, Haarlem, de Erven F. Bohn, 1921, p. 928.

fox-dog, Indian or any animal other than man has the capacity to tell what province in Ceylon yielded a certain tea; in what district in Havana a certain lot of tobacco was grown, or in just what chateau in Rheims a certain champagne was made and in what year. Such are well known (or at least claimed to be) attributes of certain human

Fig. 16.—Malone's studies (Nissl stain) of nuclei of human diencephalon. (Lettering as in figure 4.)

experts in the olfactory sphere. Hence, I would emphasize how important chemical memories (Butler) may be bound up in the "olfactory" apparatus of the human tuber cinereum and corpora mammillaria.

When, as a humanist, I state that one man's "cheese" may be another man's "epilepsy," I stand here as a provocative stimulus, perhaps, as

well as one still interested in anatomic studies. To me it is secondary that a reduction in olfactory and gustatory structures has taken place phyletically; especially when I think of the host of persons with a rich assortment of nasal and gastric symptoms; and when I look on the "pollen testers," the "protein," "horse scale," sensitizing fans and their ilk—yes, you might with me permit your sense of humor to range over the fact that some of these gentlemen are testing out the blotters on the desks, the carpets, the wall papers and the lacquer on the picture frames to discover the causes for coryzas, asthmas, etc., in some of their patients. All this, I believe must be referred to the "smell bundles of Edinger and Wollenberg," the nuclei tuberis and corpora mammillaria,

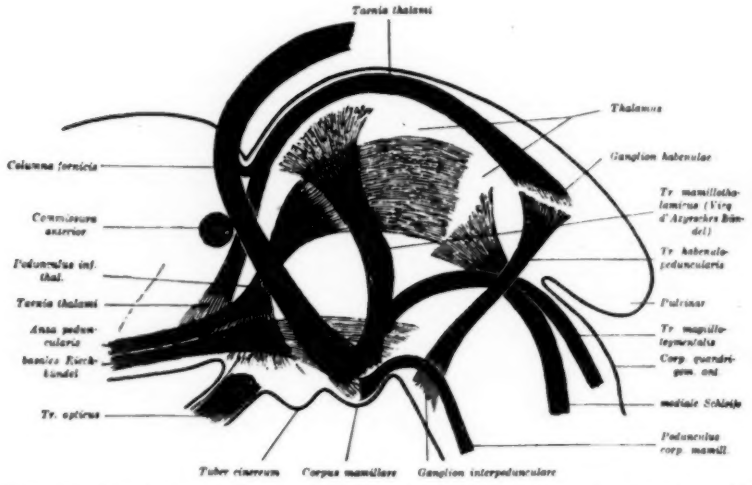

Fig. 17.—Vertical section, showing the chief fiber systems in the diencephalon (Edinger, Wallenberg, Greving).

and their further thalamic, cortical and later effector connections, for adequate comprehension.

I can only refer to Henning's and Skramlik's masterly monographs on the sense of smell to support my contention that the "humoral dogmas" behind this whole series of experimental activities are "autistic thinking." Unless one gets back to the anatomic substratum, from olfactory and gustatory stimuli (i.e., chemical memories), through the tuber cinereum, corpora mammillaria and thalamus, by means of the taenia thalami, tractus mammillothalamicus (Vicq d'Azyr's bundle), tractus mammillotegmentalis and pedunculus corporum mammillarium which convey the stimuli to the bodily effectors, be they in the nose, the stomach, the intestines, the skin, the endocrine glands or the bodily musculature, a real understanding of these numerous visceral symptoms—often neuroses, psychoses or organic disease—will not be forth-

coming—hence, the importance of a knowledge of these switchboard connections in the diencephalon.

I should like to have the time to try to outline here the connections with the cortex of these various nuclei; or, rather, indicate to you how fragmentary is the knowledge of the "gnostic" relations of these unconscious reactions. The psychoanalytic method is but one of the efforts at trying to unravel the significance of these controls. At least, this is my own vision of this particular development in the endeavor to ascertain what lies between the primitive impulses of countless animal ancestors and the means by which a conscious (cortical) control of these impulses may function for civilization and culture.

Up to the beginning of the present decennium, it has not been definitely established how the hypophysis got in direct touch with the rest of the nervous system in other than its so-called humoral manner. Percival Bailey, in his excellent summary of the functions of the hypophysis, said that up to that time (1922) the only connection of the hypophysis with the rest of the nervous system was through the orthosympathetics of the blood vessels. This sympathetic connection is old—reaching back to the saccus vasculosus of the plagiostomes and teleosts. Greving,[12] however, in 1922 to 1926, claimed to have demonstrated a definite connection of the hypophysis with the diencephalon, which he termed the tractus supra-opticus hypophyseus. This connects the nucleus supra-opticus with the neurohypophysis in a pathway passing through the tuber cinereum. Kary,[13] in 1924, made an earlier contribution and showed retrograde degenerated fibers following posterior hypophyseal injury passing through the infundibular stalk to the nucleus supra-opticus. Hence, she would designate a part of this nucleus as the nucleus parahypophyseus. Fibers from the superior and middle nuclei tuberis also pass into this same infundibular bundle and are distributed to the posterior lobe of the hypophysis. Pines [14] and Stengel [15] both seemed to have shown this.

I have made some effort to learn more of this bundle and its functions. It is now more or less extensively shown that for many cases of two of the most outstanding of the hypophyseal syndromes, acromegaly and Fröhlich's syndrome, the hypophyseal structure itself may remain intact, but that pressure interference on infundibular structures has been present. In other words, the syndromes may have resulted from cutting off of neural pathways, such as Greving's tractus supra-opticus inferior. Dr. Tilney informs me that he has not been able to confirm these observations. I cannot enter into a more extended discussion of the ques-

12. Greving, R.: Deutsche Ztschr. f. Nervenh. **89**:179, 1926.
13. Kary, C.: Virchows Arch. f. path. Anat. **252**:734, 1924.
14. Pines: Ztschr. f. d. ges. Neurol. u. Psychiat. **100**:123, 1925.
15. Stengel: Arb. a. d. neurol. Inst. a. d. Wien. Univ. **28**:25, 1926.

tion whether the vascular sympathetic connections are sufficient to explain the phenomena referred to, or whether one must further seek for more evidence about more definite effector tracts to the hypophysis. Bauer [16] concluded in his most conservative work on the internal secretions, apropos of this general situation: "Whereas it is hardly to be doubted that the hypophysis delivers its hormone to the third ventricle by way of the infundibulum it is also to be understood that the fiber pathways from the nuclei tuberis to the hypophysis also play a functional rôle, and that is to control the hypophyseal secretory activity. Thus there results a very intimate inner relationship, a functional unitary system of the basal nerve centers on the one hand and of the hypophysis on the other."

THE DYNAMIC SITUATION

In addition, if neurologists were compelled to get down to brass tacks, as an engineer in a telephone company has to in determining the dynamics of his circuits, they would not be worth their salt. This is due to the hazy conceptions about the whole group of dynamic problems in human energy interchanges, as well as to the imperfect knowledge of the "blue prints" of the nervous system connections.

As for the internist without anatomic grasp, his situation is more or less hopeless. As Zondek,[17] speaking as an internist, stated: "The vegetative system includes the colloidal marginal surface system of the primordially constituted cell plasm, as yet little differentiated, and the vegative regulators which act on the cell plasm (nerve, toxin and electrolyte). The action of the vegetative nerve, toxin and electrolyte is a uniform one; although their effective mechanisms differ, they call forth in all the organs or organ systems possessing vegetative function an alteration of function in the same direction, for example, diastole and systole in the heart. This uniformity of action of the vegetative regulators may be considered as the ground for the appearance of the same disease symptoms under entirely different conditions."

The vegetative system represents a suitable starting point for the analysis of functional symptoms and disease processes in organic diseases as well. The analysis of these processes is important, as the organomorphologic process represents but a small part of the entire disease process. One does not mean under functional processes the functional changes of the morphologically altered organ but those which have their course in the organ systems, which in fact need not be morphologically changed. Such functional processes are just as important for the understanding of a disease process as the organomorphologic process.

16. Bauer, J.: Innere Sekretion, Berlin, Julius Springer, 1927.

17. Zondek, S. G.: The Vegetative System and Its Significance in the Pathogenesis of Internal Diseases, Med. Klin. **24**:39, 1928.

In the consideration of the pathologic changes of so-called organic diseases one is prone, said Zondek, to group them merely on the organomorphologic basis, for example, renal diseases. The knowledge, however, that functional changes play just as important a part as the organ changes makes it one's duty to consider disease processes with the functional processes in the foreground. One disease picture that has, from the outset, been regarded from the functional point of view, by reason of the slightness of anatomic changes, is tetany. If the conditions under which the functional symptom "tetany" arises are sought, it can be demonstrated that it is the action of electrolytes, toxin and nerves that produces tetany—electrolytic action in the case of respiratory and gastric tetany; toxic action in guanidine and parathyreoprivus tetany, and disturbances in the function of the vegetative nervous system in the case of idiopathic tetany. All the members of the vegetative system participate in the appearance of the symptom-complex, tetany. Tetany represents a disturbance of muscle function: increased tonus, heightened excitability and tendency to spasm. If one chooses for observation instead of tetany the functional disorder edema, which is a disturbance of the movement of fluids, one can likewise prove that it may arise under different conditions; it can be shown that here, too, it is the vegetative system in which the functional disease phenomena have their course.

Ordinarily, no connection is thought of between tetany and nephrosis. There could not be any connection, since the disease is considered in the one case from the organomorphologic, and in the other from the functional point of view. A bridge does, however, lead over from tetany to edema, in which one can view functional disturbances of the fluid circulation characteristic of a nephrosis, but independent of actual changes in the kidney. The factor common to both is that they can be released through the regulators in the vegetative system; toxic effects in nephrosis; nervous effects in edema, which, as shown by one of the cases observed by Jungmann, may start, for example, from a tumor of the hypophysis; and, finally, the effects of the electrolytes in edema, which, in diabetic patients, may appear after too strong alkali content.

Then again the geography of the condition is to be considered. In tetany, the disturbance of function affects the muscle; in edema, the organ system concerned is the fluid circulation, above all in the connective tissues. Both are ushered in with changes in the distribution of electrolytes, for example, diminished calcium of the blood with tetany; alteration in the sodium content in patients with general edema, and likewise with nephrosis. Analysis of the functional processes appearing in organic diseases independently of the morphologically altered organ, especially the knowledge of the processes which form the basis of these symptoms, is so important because therapy is directed chiefly

toward these functional manifestations. By withdrawal of salt in patients with renal disease, one treats for the symptom edema, just as one gives calcium treatment for the symptom tetany without, perhaps, treating for any of the organic changes present—for example, pyloric stenosis in gastric tetany. Other leading manifestations of functional disease, such as diabetes insipidus and adynamia, may be produced in similar manner as the functional symptom-complex edema and tetany.

The morphology of the organs and the consideration of disease through pathologic changes in organs are not assumed to be of less importance because of the position here set forth; they experience, far rather, a needed extension, as is made possible by a fuller understanding of the adjustments in the vegetative nervous system.

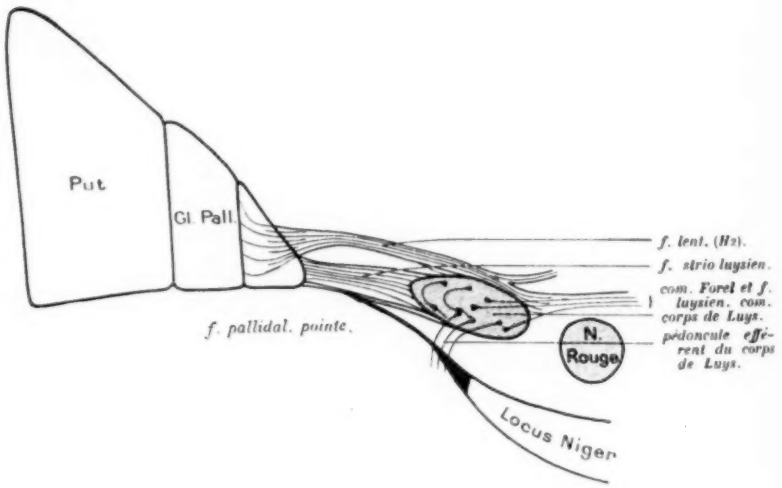

Fig. 18.—Connections of corpus luysii (Foix and Nicolesco).

Personally, I doubt nearly all purely humoral hypotheses and believe that the trend of modern research tends to show the preponderating influence of nervous regulation of practically all metabolic processes. Thus, with reference to absorption of hormones in the third or any other ventricle, especially when it is known from studies on permeability and others that absorption does not take place, I am not in sympathy with this type of interpretation of humoral activity.

All the newer researches are demonstrating that pancreas, intestines, muscle, ovary, testes, bone and other organs—thought to have few or no receptors—do in actuality have them. From all these receptors, stimuli, as well as those for touch, pain and temperature, ascend to the diencephalic structures. Here, many go on to the cortex for gnostic functioning; others are short circuited, just how must be discovered. As

Greving put it, so far as the vegetative nuclei of the hypothalamus are concerned, their direct connection with the thalamus is still to be anatomically demonstrated, save for certain restricted facts. The physiologic data seem to demonstrate the connections, especially when one relates pain stimuli to changes in the pupils, blood vessels, sweat and salivary secretions.

The hypothesis of an indirect series of pathways by way of the striatum seems to explain a number of the observations. Thus, experimental puncture of the striatum can induce hyperthermia. Through the pedunculus anterior thalami, a striking bundle of connections

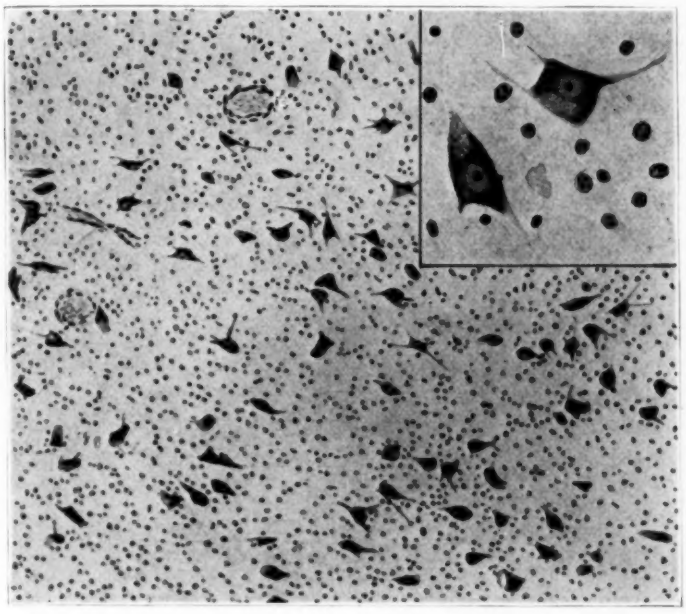

Fig. 19.—Corpus subthalamicus. Nissl detail (Foix and Nicolesco).

between the thalamus and the striatum is seen. Striofugal pathways from the corpus striatum to the hypothalamic nuclei are present: (*a*) in the ansa lenticularis which runs from the globus pallidus to the hypothalamus—this striofugal connection seems definitely established; (*b*) in the tractus frontotuberalis, the impulses from the forebrain pass to the nuclei tuberis by way of the striatum; (*c*) a tractus frontosupra-opticus passes from the cortex to the nucleus supra-opticus; (*d*) a tractus striopenduncularis goes from the striatum to the substantia nigra, and (*e*) a fiber connection in the tractus striohypothalamicus goes from the striatum to the corpus subthalamicus. The latter chain—striatum, pallidum, ansa lenticularis, corpus subthalamicus—seems to

be definitely established. The connections of the tuber cinereum and the nucleus supra-opticus are not yet so certain. Greving's conception of this connection to the hypophysis has already been referred to.

Karplus and Kreidl, some years ago, demonstrated the cortical-subthalamic connections. Through the tractus mammillothalamicus, the thalamus and the corpus mammillaris are connected, and the impulses seem to pass in both directions. The importance of olfactory stimuli in this connection has been referred to.

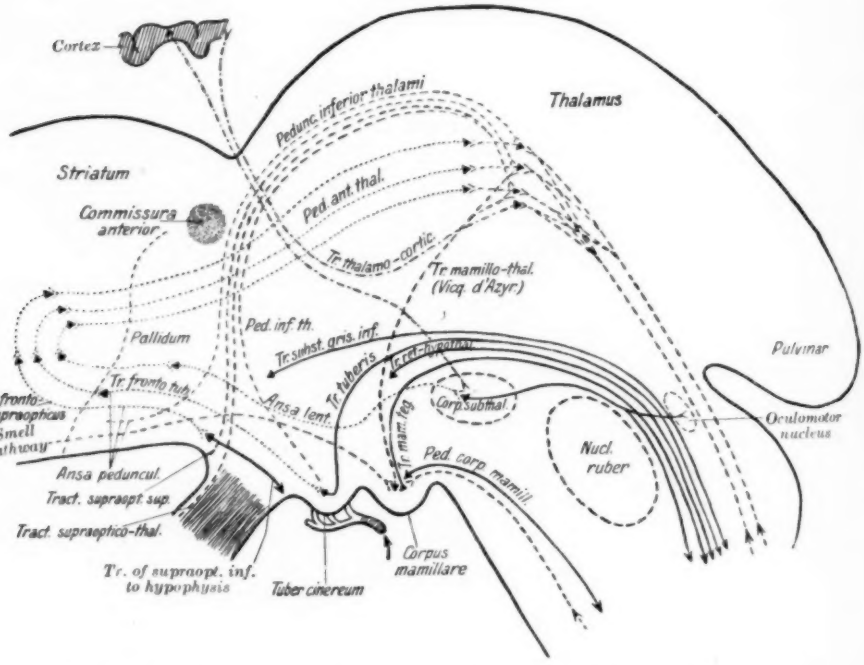

Fig. 20.—Regulatory mechanism of vegetative centers. A preliminary attempt at a schematic representation of the vegetative reflex pathways in the interbrain (Greving). (See further elaboration in Möllendorf: Handbuch der mikroskopischer Anatomie des Menschen, Berlin, Julius Springer, 1928, vol. 4, p. 917; also Jelliffe and White: Diseases of Nervous System, ed. 5, Philadelphia, Lea & Febiger, 1929, p. 163.)

Of the anatomically demonstrated centrifugal pathways of the vegetative centers may be mentioned the tractus substantiae griseae infundibuli, the tractus tuberis and the tractus reticularis hypothalami. Through the dorsal longitudinal bundle, they reach the periphery. The tractus supra-opticus inferior possibly goes to the hypophysis. The tractus mammillotegmentalis also conducts centrifugal impulses.

These mixtures of facts and suggestions are here represented in Greving's reconstruction.

ENDARTERITIS OF THE SMALL CORTICAL VESSELS IN SEVERE INFECTIONS AND TOXEMIAS*

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AND
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It is well known that cerebral symptoms may occur in infections and toxemias, especially when the condition is severe. Little if any attention has been paid to the explanation of these symptoms. Considerable work has been done in cases of syphilis and metallic poisonings in which similar symptoms have been exhibited since Nissl[1] and Alzheimer[2] described changes in the small vessels in the pia and cerebral cortex under the title "Endarteritis Syphilitica of the Small Cortical Vessels."

The effect on the small vessels would probably have little clinical significance were it not for the fact that interference with the blood supply to the cortex results. The mildest changes are those resulting from a general decrease in the blood supply to the brain, because of slight narrowing of the lumens of the small vessels. As a result, changes in the ganglion cell occur which are entirely comparable to cloudy swelling of cells in other organs. In the evaluation of these observations, however, one must not forget the direct toxic action on the ganglion cells. When the condition is more severe and swelling of the intimal cells of the vessel walls increases to such a degree that focal areas of the brain are deprived of their nourishment wholly or in part, gross lesions occur which are visible under the microscope. These may be incomplete or complete and are described by German authors as "Verödungs" or "Erweichungs-Herde," respectively.

It should be stressed at this point that the changes in the vessels are not uniform through the entire brain. One finds areas in which the small vessels are practically within normal limits, while in adjacent areas the changes may be of an intense degree. This is the explanation for the variations that occur in the clinical pictures.

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* From the Graduate School of Medicine of the University of Pennsylvania and the Wards and Laboratory of Neuropathology of the Philadelphia General Hospital.

* Read at the Fifty-Fourth Annual Meeting of the American Neurological Association, Washington, D. C., May 1 to 3, 1928.

1. Nissl: Zur Histopathologie der paralytischen Rindenerkrankungen, Histopathologische Arbeiten, 1904, vol. 1; Neurol Centrabl. **23**:42, 1904.

2. Alzheimer, A.: Progressive Paralyse und endarteritische Hirnlues, Centralbl. f. Nervenh. u. Psychiat. **16**:443, 1905.

A study of an acute case of this sort stimulated us to a further investigation of this problem. Our two original cases were reported at the joint meeting of the Section of Neurology of the Royal Society of Medicine and the American Neurological Association, in London, July, 1927, and the observations were published later in *Brain*.[3] Seven other cases have been studied carefully since, the results of which are given in this communication. A great similarity in the clinical pictures is to be stressed. While a new syndrome is not evolved, the bald clinical picture may be stated as follows: During the course of a known or unknown toxic or infectious condition the patient becomes delirious; motor and sensory irritative phenomena occur with resulting restlessness, twitchings, hyperesthesia, hallucinations and at times convulsions. Evidences of "meningismus" may be present in some cases, a phenomenon which is easily explained on the basis of the pathologic process of a serous meningitis.

REPORT OF CASES

CASE 1.—*History.*—J. A., a white man, aged 20, a mill worker, was admitted to the Philadelphia General Hospital on the service of Doctor Torrey, Aug. 30, 1923, and died there on Sept. 8, 1923. The diagnosis at entrance was typhoid fever. The history stated that on Aug. 10, 1923, the patient became ill with fever, weakness and general malaise. The temperature gradually increased, and the weakness and headache became more severe. These symptoms all persisted and apparently increased in intensity up to the time of admission to the hospital.

Examination.—The patient was in a semistuporous state; respirations were rapid; the lips and tongue were furred and dry. He appeared toxic and apathetic. There was a rapid, weak pulse. He was rather deaf. There was no nausea, vomiting or distention, although the abdomen was tender. The throat was not inflamed. The blood pressure was 95 systolic and 60 diastolic. The reflexes were normal. There was evidence of mild bronchitis. Both the spleen and the liver were palpable.

Course.—On August 31, the patient had an attack of epistaxis, and the condition grew worse from day to day. He became weaker and the stupor became deeper. He then developed distention of the abdomen. The temperature ranged from 100 to 104.5 F. The pulse rate was from 100 to 120. On September 3, it was noted that he was lethargic, that he was picking at the bed clothes and was extremely restless. On September 7, there was clinical evidence of beginning meningeal "irritation," as shown by a slightly rigid neck. On September 8, he became extremely weak, failed rapidly and died that evening.

Laboratory Analysis.—The white blood count was 5,100; the red cells numbered 4,200,000. The Widal test was positive. Cultures of the blood gave negative results. The urea nitrogen of the blood was 12 mg.; the uric acid, 3.1 mg.; the blood sugar, 120 mg. The Wassermann test of the blood was negative. A differential blood count gave 64 per cent polymorphonuclears; 35 per cent small lymphocytes, and 1 per cent transitional cells. The urinalysis showed a specific gravity of 1.020; an absence of sugar, and a trace of albumin; microscopically, it was normal.

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3. Winkelman, N. W., and Eckel, J. L.: Productive Endarteritis of the Small Cortical Vessels in Severe Toxemia, Brain **50**:608, 1927.

Postmortem Examination.—At necropsy, the brain appeared to be of normal size but was pale. There was slight thickening of the pia-arachnoid. Histologic examination of all areas of the brain showed marked proliferative endarteritis of the small cortical vessels with areas of softening throughout the cortex. Perivascular infiltration was not present. In the areas of softening the disappearance of ganglion cells was noted. Gitter cells were present in small numbers. Vascularization and congestion were evident. Glial replacement was occurring (fig 1). In places one could see where the lumen of the vessel was definitely blocked by the swollen endothelial cells. The observations in the body, in general, revealed parenchymatous degeneration of the muscle of the heart and the kidneys, with

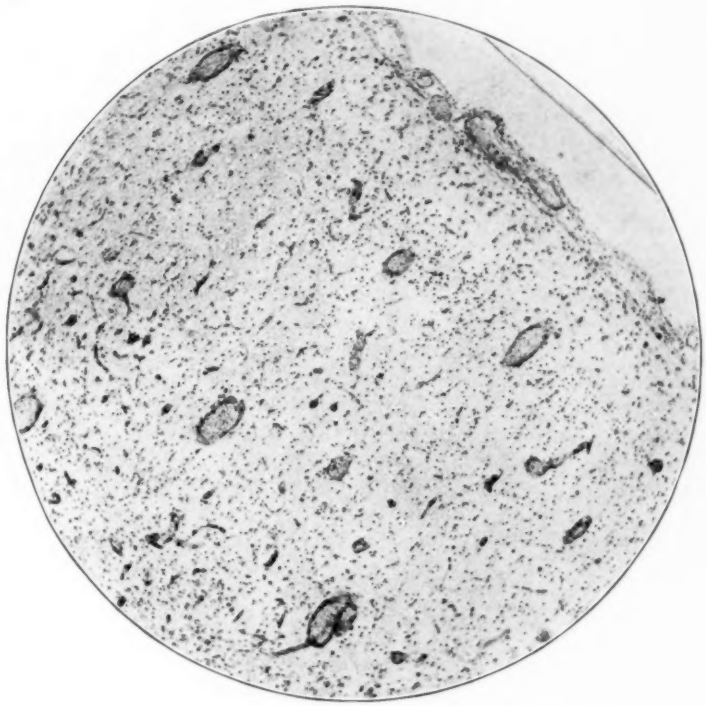

Fig. 1.—Vascularization and repair in devitalized area.

evidences of acute inflammation of the spleen. There was hemorrhagic cystitis, and the intestines showed typical typhoid patches.

CASE 2.—*History.*—M. S., a white woman, aged 33, was admitted to the Philadelphia General Hospital, service of Doctor Small, June 13, 1927, and died there on July 31, 1927. She was born in Germany and came to the United States in 1912. She was separated from her husband. She had been well until January, 1927, when she developed redness and swelling of the joints. The process spread from one joint to another. She had high fever and later marked delirium. She was in bed for ten weeks. She recovered sufficiently to do light housework, but never made a complete recovery. Shortly before admission she began to brood because of frequent swelling of the joints. Six weeks before admission her child

developed scarlet fever, following which she developed ideas of persecution and thought the police were after her for the purpose of shooting her. Twelve days before admission she thought that her child was dead and immediately took some "poison." She then went to New York, where she was sent to Bellevue Hospital. While there she had hallucinations, saw all sorts of imaginary aeroplanes, dances and other images and thought that she was being poisoned. On admission to the hospital she was mentally retarded, refused to speak, was dejected and had to be fed with a spoon. The diagnosis on entrance was rheumatic fever with toxic melancholia. She was sent to the psychopathic ward because of attempted suicide.

Examination.—The tonsils were small and ragged. The heart presented no murmurs. The muscle tone of the heart was poor. The blood pressure was 140 systolic and 90 diastolic. She had some swelling of the joints. The temperature averaged 100 F. The respiration rate was 20, the pulse rate from 100 to 120. She was given 50 cc. of antirheumatic serum. This produced no improvement. She failed rapidly and just before death the pulse rate rose to 156.

Laboratory Examination.—The urine showed hyaline casts and a trace of albumin. The red blood count was 3,000,000; the white cell count 11,400, with a differential count of 77 polymorphonuclears, 21 lymphocytes and 2 per cent eosinophils. The Wassermann test of the blood was negative. The blood sugar was 71 mg.; the urea nitrogen, 15 mg. The spinal fluid gave a negative Wassermann test and a negative gold curve. Serum from the patient agglutinated the streptococcus cardio-arthritidis in a dilution of 1:40.

Postmortem Examination.—The general pathologic changes showed rheumatic endocarditis, rheumatic myocarditis and atheroma of the aorta. The pleuras were adherent, but the lungs were normal. There was acute congestion of the liver. The brain grossly showed congestion. Microscopically, the pia was edematous and contained numerous phagocytic cells laden with pigment. In the cortex two processes stood out: (1) a marked proliferative endarteritis of the small vessels, which was mainly limited to the gray matter, and to a much less extent in the gray basal nuclei; (2) small areas of partial and complete softening were scattered throughout the cortical gray matter (fig. 2).

Case 3.—*History.*—L. D., a colored woman, aged 22, was admitted to the Philadelphia General Hospital, service of Doctor Ludlum, Oct. 7, 1927, and died Oct. 8, 1927. The husband stated that he thought she was pregnant about four months. She had vomited all food during the past nine weeks and had complained of severe headaches. She had lost 35 pounds (15.9 Kg.) in weight.

Examination.—The patient was admitted in a moribund condition. The diagnosis was toxemia of pregnancy with pernicious vomiting. The eyes were rolled up. She was haggard and the mouth was open. The lips were covered with sordes. The skin was moist and clammy, and she was in a state of muttering delirium. Carphologia and subsultus tendinum were present. Respirations were rapid and irregular, averaging about 40 per minute.

The pupils were dilated and sluggish. The corneal reflexes were absent. The scleras were glazed but not jaundiced. The heart beat was 146 per minute and irregular. Murmurs were not present. There were occasional twitchings of the abdominal muscles. The cervix was soft, and the uterus was enlarged to about the size of that of a three months' pregnancy. The extremities were dry and cold. All the tendon reflexes were active and about equal. The twitching of the muscles interfered with the proper response of the reflexes. The blood pressure was not obtainable. She became progressively weaker and lived less than twenty-four hours after admission to the hospital.

Postmortem Examination.—The necropsy revealed marked parenchymatous and fatty degeneration of the liver and a nephrosis (the kidney of pregnancy). The brain grossly showed marked congestion. Microscopically, the brunt of the pathologic change was borne by the vessels of small caliber, many showing a considerable swelling and proliferation of the lining cells. In others, the process was more advanced, as shown by hyalinization of the vessel walls, with shrinkage and irregularity of the nuclei of the intimal cells. The white matter particularly showed degeneration which was manifested by the presence of greenish pigment-containing phagocytic cells in the perivascular spaces of many vessels. Similar cells were also found in the subarachnoid spaces. The ganglion cells, especially the larger elements, showed acute changes.

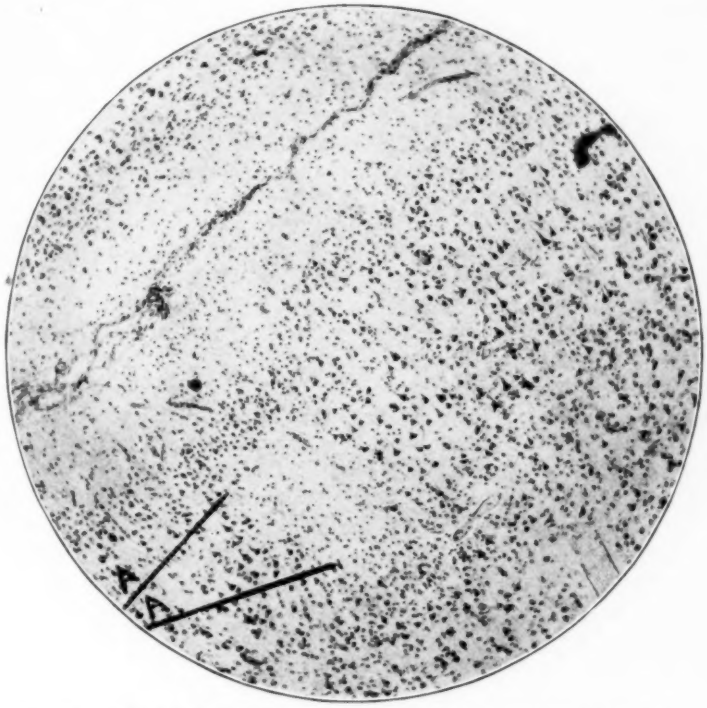

Fig. 2.—Small "Verödungs Herde" in the third cortical layer (*A*).

Case 4.—*History.*—A white infant, aged 20 months, was admitted to the Philadelphia General Hospital, service of Doctor Doane, March 24, 1927. The diagnosis on admission was erysipelas universalis. The child was of instrumental delivery but was full term. She was of normal physical development and had been able to walk until the time of her illness. The illness began two months before admission to the hospital with fever and restlessness. The following day a red area appeared over the nose; it gradually extended to the eyes and lips and then over the cheeks. In three days it had covered the entire face, and the patient became extremely ill. This redness gradually extended to the neck and scalp and slowly progressed until eventually the entire body was involved. The temperature gradually increased, with the spreading of the redness and swelling, from 100 to 106 F.

Examination.—There was generalized redness over the entire body. There was bilateral nystagmus and right internal strabismus, which, the history stated, had been present from birth. The pupils were of medium size, round, equal and reacted promptly. There were twelve teeth. All the tendon reflexes were present and equal. The pulse rate was 110 and regular. The heart action was feeble. Murmurs were not heard. A week later there was a definite systolic blow at the apex. One week after admission, even though the redness began to clear, she became toxic and delirious; she gradually became weaker and died.

Laboratory Analyses.—The urine showed a trace of albumin with many leukocytes and an occasional red blood cell. The blood showed 18,000 white cells with 80 per cent polymorphonuclears.

Postmortem Examination.—Necropsy revealed dilatation of the auricles of the heart and congenital malformation. Lobular pneumonia was present with marked swelling of the kidneys. The brain weighed 720 Gm. The pia appeared normal. The basilar vessels were normal. There was edema of the cut surface of the brain. The ventricles were small. Sections were taken from all areas of the brain and preserved both in 80 per cent alcohol and in formaldehyde. The microscopic examination revealed marked prominence of the small cortical vessels, with swelling and proliferation of the endothelial cells of the vessel walls (similar to figures 5 and 6 of our former contribution[3]). This process was practically limited to the cortical vessels. The picture was that of an advanced progressive endarteritis of the small vessels.

Case 5.—*History.*—A. B., a white man, aged 36, was admitted to the Philadelphia General Hospital, service of Doctor Stevens, Sept. 25, 1927, and died there on Sept. 30, 1927. The diagnosis on admission was Hodgkin's disease and toxic jaundice. He had had the ordinary diseases of childhood. He said that he had not had venereal disease. The symptoms began in April, 1927, when he noted that he fatigued easily and became drowsy; later, when his temperature was 105 F., he presented himself to a physician. He had had frequent spells of vomiting and profuse sweating, with occasional chills. Two weeks before admission, jaundice appeared. He had had cervical adenopathy for three years. His weight was reduced from 234 (106.1 Kg.) to 154 pounds (69.9 Kg.) during this time. He had incontinence of the bowels and bladder.

Examination.—The patient was jaundiced. He was severely toxic and confused. The scleras were yellow. The pupils were of medium size, round, equal and reacted to light and in accommodation. Râles were present throughout both lungs. The heart sounds were weak, although murmurs could not be heard. The abdomen was tympanitic, and there was fluid in the flanks. The liver and spleen were both enlarged, extending about 2 inches (5.08 cm.) below the free border of the ribs. The speech was disconnected, and therefore definite or reliable information could not be obtained from him. He failed rapidly and died within one week after admission.

Laboratory Tests.—The urine was dark and scanty; its specific gravity was 1.015; it contained a trace of albumin and many hyaline casts. The blood showed: hemoglobin, 7.5 Gm.; red cells, 2,000,000; white cells, 5,600. The differential count revealed, polymorphonuclears, 75, small lymphocytes, 24, and eosinophils, 1 per cent. There was a slight tendency to irregularity in the size and shape of these cells. The temperature ranged from 101 to 103 F. The pulse rate ranged from 130 to 140, and respirations from 30 to 40. A Wassermann test of the blood gave a negative reaction.

Pathologic Examination.—The heart showed slight hypertrophy. There was parenchymatous degeneration of the heart muscle. The aorta was normal. The lungs showed granulomas of Hodgkin's type, as did the spleen, liver and lymph nodes. The thyroid contained colloid. The pancreas and suprarenals were normal. Grossly, the brain was pale. The pia-arachnoid was thickened. Microscopically, endarteritis of the small cortical vessels was the outstanding feature of the picture. The intimal cells were swollen and projected into the vessel lumen. While this was most marked in the cerebral gray matter, the same changes could be seen to a much less degree in the white matter. The ganglion cells showed acute degenerative changes. The pia contained numerous pigment-laden phagocytic cells. The larger vessels were uninvolved.

CASE 6.—*History.*—W. G. M., a colored chauffeur, aged 16, was admitted to the Philadelphia General Hospital, Aug. 5, 1927, and died there on Sept. 9, 1927. He had been epileptic as a small child and was never strong. He had had a cough for four years which gradually improved and disappeared four months previous to his admission. There was a history of loss of weight and of night sweats. He said that he had not had venereal infection. There was considerable expectoration.

Examination.—The patient was a fairly well developed colored boy. The pupils were round, equal and reacted promptly. The eyegrounds were normal. The teeth were normal. The cranial nerves were not involved. Examination of the lungs revealed numerous râles at the right apex. The heart was normal in size and position, and there were no murmurs. The right side of the lower part of the abdomen presented a draining psoas abscess which had been opened in July, 1927. Shortly after admission, he developed a sore throat with membrane formation. The temperature rose to 101.6 F. and the pulse rate to 100. Cultures of the throat for diphtheria were negative. The membrane spread over the left palate to the upper pillars of the fauces. He became toxic and occasionally was irrational. At times he complained of diminished vision. Following this, the eyegrounds revealed choking of the disks. He failed rapidly and died within a month.

Laboratory Examination.—The urine contained albumin and an occasional cast. The Wassermann reaction of the blood was negative.

Postmortem Examination.—Examination showed tuberculous epicarditis, miliary tuberculosis of the kidneys, bilateral psoas abscess and tuberculosis of the lumbar spine. The brain weighed 1,280 Gm. The pia-arachnoid was thin and transparent, and there was slight convolutional atrophy. The basal vessels were small, and their walls were normal. Microscopic examination of sections from all portions of the brain showed that the small vessels in the meninges were thickened, and that hyalinization had taken place in some. There was marked evidence of swelling in the intimal cells of the small cortical vessels. Areas of softening were not found. The small vessels in the white matter were much less affected. The vessels in the basal nuclei were also much involved. Inflammatory changes had not occurred. Gitter cell accumulation in the meninges bore evidence of the generalized degeneration taking place throughout the brain. The large vessels were not involved.

CASE 7.—*History.*—A. K., a white man, aged 22, was admitted to the Philadelphia General Hospital, service of Doctor Lowenberg, April 5, 1927, and died there on April 13, 1927. The diagnosis on entrance was atrophic biliary cirrhosis, chronic alcoholism, pneumonia and diffuse nephritis. He was unable to speak English; so it was difficult to obtain a reliable history.

Examination.—The patient was a poorly nourished man. He was irrational, hallucinated and was extremely active. He was jaundiced. There was cyanosis of the lips and fingers. He was incontinent. The pupils were irregular but reacted

to light and in accommodation. There was a low grade, purulent conjunctivitis. The mouth was dry, and the lips were cracked. The chest was emphysematous, and râles were present throughout both lungs. There was slight enlargement of the heart toward the left. The sounds were regular, but the muscle tone was poor. The tendon reflexes were present but diminished. The temperature on admission was 97 F., and it slowly increased until it reached 104 F. just prior to death. The pulse rate ranged around 130 on admission and gradually decreased to 90; just prior to death it rose to 130. The respiration rate varied from 25 to 35. On April 11, he developed lobar pneumonia and died the next day.

Laboratory Tests.—There was a trace of albumin in the urine, with an occasional hyaline cast, a few granular casts and many red blood corpuscles. The Wassermann reaction of the blood was negative. Examination of the blood revealed: the blood sugar, 60 mg. per hundred cubic centimeters; the urea nitrogen, 18 mg.; the white cell count, 18,000, of which 80 per cent were polymorphonuclears.

Postmortem Examination.—Necropsy revealed lobar pneumonia and acute catarrhal enteritis. The brain grossly showed edema. Microscopically, sections taken from all portions of the brain showed the following changes: The pia was fibrotic and contained within its meshes groups of phagocytic cells with a tendency to perivascular location. In the brain itself the important and outstanding features were the changes in the small vessels in the cortex, consisting of swelling and proliferation of the intimal cells. New vessel formation could easily be made out. Occasional foci (Verödungs Herde) with loss of ganglion cells could be seen (fig. 3). The vessels in the white matter and in the basal ganglia were involved to a much less degree. The larger vessels all remained passive. No inflammatory changes were determined.

COMMENT

Our attention was forcibly called to this subject by finding, in a child, aged 7, who had been poisoned by tainted meat, a condition in the small vessels of the cortex which had previously been described, mainly in syphilis and in metallic poisoning. Isolated instances had also been reported in typhoid and typhus by Spielmeyer,[4] and in malignant malaria by Cerletti.[5] This change in syphilis had been named by Nissl [1] and Alzheimer [2] endarteritis syphilitica of the small cortical vessels. Even in syphilis this condition is admittedly rare. Since our attention had been directed to the condition we have met with a fair number of diseases which may affect the small vessels in a manner similar to the Nissl-Alzheimer type of endarteritis.

Thorough study has been made of all these cases, a brief outline of which has been given with each case report. Large representative sections were taken for study from all parts of the central nervous system. We have used mainly alcohol-fixed material in which the cellular pathologic changes were well brought out by the Nissl method. The pathologic

4. Spielmeyer, W.: Die zentralen Veränderungen beim Fleckfieber und ihre Bedeutung für die Histopathologie der Hirnrinde, Ztschr. f. d. ges. Neurol. u. Psychiat. **47**:1, 1919.

5. Cerletti, N.: Die histopathologischen Veränderungen der Hirnrinde bei Malaria perniciosa, Nissl's Arbeiten, 1911, vol. 4, p. 169.

process can be divided for convenience into two stages. In the acute stage the lining cells of the small vessels become swollen. If the process continues, mitosis can be seen with proliferation, budding and new vessel formation. When the condition is hyperacute, the swelling may be so intense that the vessel lumen is occluded and small areas of incomplete and complete softening may take place (Verödungs or Erweichungs Herde). The adventitia may take part in the process with swelling and proliferation of its cells. The media, however, is not involved, except by edema.

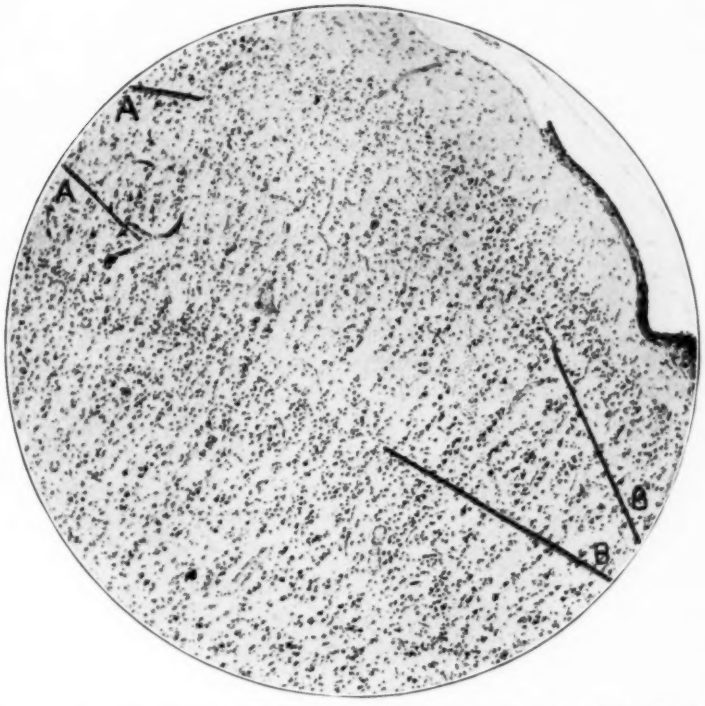

Fig. 3.—A large area of incomplete softening in second, third and fourth cortical layers outlined between "*A*" and "*B*."

In the chronic stage, retrogression takes place; the intimal and adventitial cells become shrunken and irregular and the media becomes hyalinized.

As a result of the acute process, secondary changes take place in the brain substance. Changes in the ganglion cells occur first. They may consist merely of loss of Nissl substance or that rare condition of acute swelling of the ganglion cells. The glia does not remain passive. There is proliferation as part of the general picture of the changes in the ganglion cells. It is probably dependent to a great extent on the cutting down of the blood supply, or to the direct action of the toxin or to the infection on the cells. Catabolic changes in the brain substance are well

shown by the presence of perivascular accumulations of gitter cells laden with pigment, many of which are also present in the subarachnoid space, and the irritation may be one of the causes for the proliferation of the pia which is found in all these cases. It is remarkable that the larger vessels remain more or less passive, the condition being almost entirely limited to vessels of small caliber. Evidences of inflammation are entirely lacking. The condition is not to be considered in any sense as an encephalitis, although the clinical picture may resemble encephalitis to a marked degree. The presence of areas of incomplete softening may be explained by the partial blocking of the vessel lumens by the swollen endothelial cells. In complete obstruction to the blood supply the characteristic changes of acute death of nerve tissue with coagulation necrosis are found, then mobilization of gitter cells and vascularization with repair (fig. 1). In the incomplete foci there is a loss of ganglion cells with partial glial replacement and with little, if any, gitter cell accumulation or vascularization (figs. 2 and 3).

The explanation of the involvement of the gray matter and the almost complete sparing of the white matter may be found in the recent work of Pfeifer,[6] "Angio-architecture of the Cortex," a theory which Cohnheim [7] and Duret [8] brought forth many years ago to explain conditions which they found. According to these recent investigations, two sets of vessels enter the brain from the pia. Those vessels destined mainly for the supply of the gray matter are short and branch immediately on entering the brain substance, there being considerable agreement between the cyto-architecture and the angio-architecture, as shown by areas of striate softening in arteriosclerosis, which may be limited to certain cortical layers, for example, the third. This has been well demonstrated by the work of Stewart,[9] in England, in carbon monoxide poisoning, also by Wilson and Winkelman,[10] and by Grinker [11] and Hiller,[12] in Germany, in the same condition and recently in arteriosclerosis. The second group

6. Pfeifer, R. A.: Die Angioarchitektonik der Grosshirnrinde, Berlin, Julius Springer, 1928, p. 111.

7. Cohnheim, J.: Untersuchungen ueber die embolischen Prozesse, Berlin, 1872.

8. Duret, H.: Recherches anatomiques sur la circulation de l'encéphale, Arch. de physiol. norm. et path., 1874, vol. 6; Revue critique de quelques recherches récentes sur la circulation cérébrale, Encéphale **1**:7, 1910.

9. Stewart, R. M.: Cortical Changes in Carbon Monoxide Poisoning, J. Neurol & Psychopath. **1**:125, 1911.

10. Wilson, G., and Winkelman, N. W.: An Unusual Cortical Change in Carbon Monoxide Poisoning, Arch. Neurol. & Psychiat. **13**:191 (Feb.) 1925.

11. Grinker, R. R.: Parkinsonism Following Carbon Monoxyd Poisoning, J. Nerv. & Ment. Dis. **64**:18, 1926.

12. Hiller, F.: Ueber die krankhaften Veränderungen in Zentralnervensystem nach Kohlenoxydvergiftung, Ztschr. f. d. ges. Neurol. u. Psychiat. **93**:594, 1924.

of vessels is made up of longer branches, which give collaterals to the gray matter and anastomose with the short vessels, but their supply is mainly for the white matter. The selective involvement of the tissue supplied by these vessels is illustrated by such conditions as Schilder's "periaxial encephalitis" and in Binswanger's subcortical encephalomalacia.

In most of our cases we have observed that the liver has been severely affected. Acting on this suggestion we have been collecting the brains of patients who have died from severe disease of the liver, especially those of young people. A full report of these cases will be made later. Enough has been found to justify proceeding with the study.

From the practical standpoint the question naturally arises whether this condition is of clinical importance; in other words, is there a characteristic group of symptoms by which one can foretell the presence of this pathologic process? In our experience, the conditions in which endarteritis of the small cortical vessels has occurred have been toxic and infectious processes of the severest forms. The patients have usually been delirious or stuporous. They have shown motor and sensory irritative phenomena, such as twitchings, subsultus tendinum, hyperesthesia, visual and auditory hallucinations and at times convulsions. When focal loss of tissue has occurred from complete or incomplete occlusion of vessels, the symptoms have been referable to that part of the cortex involved. In those patients who are mildly delirious, semicomatose or comatose, however, accurate cortical localization has not been possible. The areas involved have naturally been small. Gross hemiplegias have not occurred. The pouring into the subarachnoid space of degenerative material has given rise in some of these cases to evidences of meningeal irritation. Pulse rate and temperature increases have been the rule. Patients have succumbed from the overwhelming toxemia from its direct toxic effect on the heart, liver and kidneys.

It might be interesting to speculate on the treatment in these conditions. There is no doubt in our minds that the altered chemistry of the blood is directly responsible for the condition. It is well known that under conditions of altered acidity and alkalinity swelling of cells occurs. This chemical change, of course, is produced by the toxic or infectious agents present in the blood stream. Theoretically, an attempt to restore the normal p_H of the blood by intravenous or oral administration of mildly acid or alkaline solutions should be of value.

SUMMARY AND CONCLUSIONS

1. Seven cases are described of changes in the brain in severe infections and toxemias. These conditions include typhoid fever, acute rheumatic fever, toxemia of pregnancy, erysipelas, Hodgkin's disease, chronic tuberculosis and an undetermined toxic condition.

2. The clinical picture consisted of delirium, at times of a most severe degree, with increase of psychomotor activities such as restlessness, muscle twitching and even convulsions; hyperesthesia, visual and auditory hallucinations and meningeal irritative signs were at times present. It was more a meningismus than a real meningitis.

3. Pathologically, the predominant change occurred in the small cortical vessels with resultant secondary manifestations in the brain substance. The lining cells of the small vessels showed swelling and proliferation, with formation of new vessels. Scattered throughout the cortex were small microscopic areas of partial or complete softening resulting from cutting off the blood supply by the swollen endothelial cells. Cloudy swelling in the ganglion cells was a universal observation. Reactive glial formation occurred. Evidences of inflammation were everywhere absent. The process was not an encephalitis.

4. In the chronic stages, regression occurs. The endothelial cells of the vessels become shrunken and atrophic; the media becomes swollen and hyalinized and the adventitia fibrous. Organization takes place in the areas deprived of their blood supply.

5. Recent work from the chemical standpoint of altered p_H of the blood in toxemias and infections may well account for the pathologic manifestations. Therapy directed toward this altered chemical state offers theoretically the best possibility.

ABSTRACT OF DISCUSSION

Dr. S. D. Ludlum, Philadelphia: In our experiments with cells, we have found the same changes of swelling in leukocytes from the blood of different persons as these gentlemen have found in glia cells. Our work has indicated that the process of swelling does not depend on p_H alone, but also on the concentration of salts in the fluid medium. Our experiments consisted of adding various concentrations of different salts, as sodium, potassium, magnesium, calcium and others to fresh blood under the cover glass. According to this method, the swelling or shrinking appears to be mainly due to change in osmotic tension.

In studying fresh brain tissue, we found that the same thing was true of brain cells as of leukocytes, so it would seem that the leukocytes may be used as an index of the condition of the brain cells. If a piece of cortical tissue is removed and solutions of potassium chloride or magnesium chloride are added to it, in different concentrations, the same change, which depends on osmotic tension, results. This brings one back to the biologic principle of concentration of fluids surrounding tissues, with consequent change of swelling or shrinking, which has been reported as occurring in this condition.

In a situation where there is an endarteritis due to any sort of infection, such as Dr. Winkelman has reported, there is set up a change in hydrogen ion concentration with a concomitant change in the emulsoid state of the adjacent fluids and a swelling of the cells — the leukocyte, glia cell and nerve cell, etc., and this may extend, becoming more generalized and resulting in mental disorder.

Another thing of particular interest which we have studied with the ultramicroscope is the form which coagulated fibrin takes which cannot be differentiated

either morphologically or by staining from certain types of glia. Photomicrographs which we have made of cut and stained sections of coagulated fibrin cannot be differentiated from glia found in marginal areas of the brain in which spinal fluid or blood serum are present in pathologic conditions. This makes me think that fibrous glia is only coagulated fibrin of blood serum or spinal fluid present in the brain tissue, which is of special interest here in connection with the vascular changes reported.

DR. N. W. WINKELMAN: Neurologic literature is full of the same thing under different names. No one has found inflammatory changes in this particular type of blood vessel change, and in a recent number of the *Festschrift für die gesamte Neurologie und Psychiatrie,* Kufs has emphasized the fact that no one has found the spirochete or inflammatory change in this condition; we have, likewise, found no inflammatory change connected with this disease.

As to the name, we have tried to call it in previous work "proliferative endarteritis." We do not want to give it a new term. When we use the term to describe syphilis, we use endarteritis syphilitica. In this, we simply use "endarteritis." I think that this is sufficient distinction.

DR. S. D. LEOPOLD, Philadelphia: It has been some time since I have worked in general pathology, but I recall certain focal degenerations present in the viscera, especially the liver, in cases of typhoid fever, which were similar to the pathologic changes described by Dr. Winkelman in the series of cases of studies of the brain. I would like to know whether Dr. Winkelman has studied other organs in his series, especially the liver. In the cases that I studied years ago, the changes in the viscera showed a focal degeneration without the inflammatory change.

DR. WINKELMAN: In closing: Replying to Dr. Leopold, we are not prepared to give our observations on the changes in the liver or the changes in brain from diseases of the liver. We have collected about twelve cases and they are now in process of being studied. At some future date we hope to be able to answer that question.

NEW VESTIBULAR COMPLEXES FOR LOCALIZATION OF LESIONS OF THE BRAIN

AN ANALYSIS OF ONE HUNDRED AND THIRTY-NINE VERIFIED LESIONS *

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In 1926, we published from this clinic [1] our experience with the vestibular reactions in 116 verified intracranial lesions. In the present contribution, we propose to review the vestibular reactions, especially in pretentorial lesions, with a view to determining whether they present syndromes which would be an aid to localization.[2]

This series of cases by no means represents the total number which were observed in the clinic and were studied by us. Several thousand patients were examined, but unfortunately many cases were unverified, while others, though verified by autopsy or operation, could not be utilized because the charts were incomplete. The accompanying table shows the number of lesions constituting this series with their location in the respective regions of the brain.

For the purpose of more clearly presenting the observations necessary for the diagnosis of a lesion of the brain by means of the vestibular tests, this paper has been divided into the following sections:

Observations Indicative of a Lesion of the Brain.
The Value of Vestibular Tests in the Determination of Increased Intracranial Pressure.
Observations Indicative of a Supratentorial and a Subtentorial Lesion.
Observations Indicative of the Laterality of the Lesion.
Vestibular Group Observations Diagnostic for Each Anatomic Area.
Differential Diagnostic Signs Between Various Anatomic Areas.

OBSERVATIONS INDICATIVE OF A LESION OF THE BRAIN

Spontaneous Vertical Nystagmus.—Small nystagmoid movements of the eyes on looking to the extreme right and left may be present in normal persons, but a nystagmoid movement of considerable amplitude

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* From the Neuro-Surgical Clinic of Dr. Charles H. Frazier, University of Pennsylvania, and the Neuro-Otologic Clinic of the University of Pennsylvania.

1. Fisher, L., and Grant, F. C.: J. f. Psychol. u. Neurol. **34**:113 (Oct.) 1926.

2. This study was made possible through the cooperation and interest of Dr. Charles H. Frazier, whose Neuro-Surgical Clinic supplied most of the cases, and Dr. W. G. Spiller and Dr. Theodore H. Weisenburg, whose encouragement and aid helped in the development of neuro-otology.

in any direction is pathologic. These spontaneous nystagmoid movements may be horizontal—to right or left; rotary—to right or left; vertical—up or down. While it is true that well developed spontaneous nystagmus in any direction indicates a pathologic condition, it is only the

Number of Lesions and Their Location in the Brain

A. SUPRATENTORIAL	
I. HEMISPHERIC	
Frontal lobe	11
Frontoparietal	2
Frontotemporal	1
Motor area	10
Parietal	1
Temporal	6
Motor temporal	2
Occipital	3
Junction temporoparieto-occipital	4
Intraventricular	2
Corpus callosum	1
II. MIDCENTRAL TUMORS	
Pituitary	11
Suprasellar	6
Third ventricle	3
Corpora quadrigemina	1
Pineal	1
	65
B. SUBTENTORIAL	
III. CEREBELLAR TUMORS	
Midline	6
Midline, with pontile involvement	2
Cerebellar lobe	25
Cerebellar lobe with involvement of angle	4
	102
IV	
Cerebellopontile angle tumors	37
Total	139

vertical spontaneous nystagmus which is of interest in this study, because such a nystagmus always indicates a lesion of the brain. The other types of spontaneous nystagmus, horizontal or rotary, may be produced either by a lesion of the brain or by a peripheral lesion (labyrinthitis, etc.), and therefore are not always indicative of a lesion of the brain. Vertical nystagmus, on the other hand, is never observed in

peripheral lesions and is, therefore, a true infallible and pathognomonic sign of a pathologic condition of the brain. This observation was first made by Robert Bárány and is fully corroborated in our experience.

Poor Pelvic Girdle Movements.—This test is performed in the following manner: The patient stands erect, with heels and toes together, eyes closed and arms to the side. The examiner then attempts to push the patient to the right, to the left, forward and backward. The ability of the pelvic girdle to compensate for the various displacements from the upright position is then noted. A normal person will compensate against this attempt to overthrow him by flexing his body at the hips and thus preventing loss of balance. A person with a lesion of the brain loses this flexibility of the pelvic girdle, and when an attempt is made to overthrow him he falls over more readily.

Nystagmus and Vertigo.—There is a marked disproportion between nystagmus and vertigo after turning.

Reactions from the Semicircular Canals.—There is a marked disproportion in the activity or duration of the responses from the horizontal and vertical semicircular canals of the same side after douching, such as: (*a*) no nystagmus from the vertical canals, but good nystagmus from the horizontal canal; (*b*) much delayed, or slow nystagmus from the vertical canals, and good, active, rapid responses from the horizontal canal.

Vertical Canals.—There is a loss of nystagmus from the vertical canals, but past-pointing is present.

Perverted Nystagmus.—There is a perverted nystagmus from either horizontal or vertical canals after douching. The perversion of the nystagmus from the horizontal canal may vary from a slight obliquity to almost a vertical nystagmus, or it may be rotary instead of horizontal. The more marked the perversion, the stronger the evidence that the lesion is intracranial.

Perversion of Direction.—Vertigo or past-pointing in the wrong direction may be present after stimulation.

Movements of Eyes.—There is a dissociated movement of the two eyes, after stimulation.

Vestibular Responses.—A loss of all vestibular responses occurs after stimulation, with good hearing.

Deviation of Eyes.—A conjugate deviation of the eyes is present after stimulation, instead of a full nystagmus.

In all cases presented, one or more of the conditions stated existed. While the presence of these phenomena indicates a lesion of the brain, it does not indicate the nature of the disturbance. The lesion may be a tumor, large or small, a degenerative process, inflammation, hemorrhage or even a toxic state.

THE VALUE OF VESTIBULAR TESTS IN THE DETERMINATION OF INCREASED INTRACRANIAL PRESSURE

Up to the present analysis, it was considered that some of the abnormal responses to stimulation of the ear, such as loss of the function of the vertical canals, perverted nystagmus from the horizontal canal and spontaneous vertical nystagmus, were indicative of an increase in generalized intracranial pressure. However, in this analysis it was found that in many cases with the spinal manometric pressure tremendously increased, none of the phenomena named were present; and, conversely, in some of the cases in which the same vestibular phenomena were marked, the spinal manometric pressure failed to show any increase. It is obvious, therefore, that these vestibular conditions do not indicate generalized increased intracranial pressure as such. The abnormal observations, however, indicate a lesion of the brain, and since they are not always produced by actual destruction, they must be produced by pressure of some sort, probably local pressure.

OBSERVATIONS INDICATIVE OF A SUPRATENTORIAL AND A SUBTENTORIAL LESION

It is needless to dwell on the importance of differentiating between supratentorial and subtentorial lesions from a surgical standpoint. This analysis of 139 cases offers an excellent opportunity to determine what observations make such a differentiation possible.

One of the most salient diagnostic signs is the patient's susceptibility to stimulation of the ear. Patients with a subtentorial lesion do not become nauseated, vomit or perspire, regardless of the amount of stimulation administered. On the other hand, patients with a supratentorial lesion are frequently quite susceptible, to a degree varying with the location of the lesion.

It is extremely important to note that susceptibility of a patient to stimulation of the ear definitely excludes the presence of a lesion of the posterior fossa, but immunity from disturbance does not necessarily place the lesion subtentorially, because certain patients with supratentorial lesions are also unsusceptible to stimulation of the ear. It is also well to remember that normal persons are frequently upset by stimulation of the ear. Therefore, this phenomenon, appearing during the examination of a patient, does not necessarily indicate the presence of a lesion of the brain, but it does indicate that if a lesion is present it is not subtentorial. Should a patient show no susceptibility during a vestibular examination, one must rely on some of the other observations for differentiation, such as poor movements of the pelvic girdle, impaired vertigo and past-pointing, presence of a marked spontaneous nystagmus or evidence of actual involvement of the fibers of the horizontal canal.

These various observations, when taken in combination, enable one to make a differentiation.

In the cases analyzed, susceptibility was noted in patients with lesions of the frontal lobe, the motor area, the temporoparietal area and the pituitary and suprasellar regions. Susceptibility to stimulation was absent in patients with lesions of the temporal lobe, lesions of the occipital lobe and all subtentorial lesions.

OBSERVATIONS INDICATIVE OF THE LATERALITY OF THE LESION

Cerebral Lesion.—The side on which a cerebral hemispheric tumor is located may be indicated by the following observations:

1. Uncertain spontaneous pointing, or uncertain past-pointing of the arm or leg after stimulation, indicates a lesion on the opposite side (seventeen cases). It is well to bear in mind that the mere ability of the patient to find the examiner's finger does not necessarily indicate normal pointing; but the manner in which the patient finds the examiner's finger should be carefully noted. Even if the movement is not definitely ataxic or asynergic it may be extremely uncertain and, therefore, pathologic.

2. Conjugate deviation was present after stimulation to the side of the lesion (seventeen cases).

3. Interference with, or an absence of, all vestibular responses from one ear indicates a lesion of the opposite side (seven cases).

4. Perversion of the nystagmus from the horizontal semicircular canal indicates a lesion on the same side (seven cases).

By means of these signs, the correct side was localized in thirty-one of forty-three patients. The other twelve patients did not have lateralizing signs.

Cerebellar Lesions.—The side on which a cerebellar lesion is located may be indicated by the following:

1. Uncertain pointing of the arm or leg on the same side (six cases).

2. Interference with or loss of all vestibular responses after stimulation on the side of the lesion (nine cases).

3. Impairment of nystagmus from the horizontal semicircular canal on the same side (eight cases).

4. Interference with responses from the vertical semicircular canals on the same side (ten cases).

5. Deafness on the side of the lesion.

In three cases the side of the lesion could not be placed, and in one case it was wrongly placed.

In cases of lesions of the cerebellopontile angle, the tumor was always found on the side on which the entire function of the eighth nerve was disturbed.

VESTIBULAR GROUP—OBSERVATIONS DIAGNOSTIC FOR EACH ANATOMIC AREA

SUPRATENTORIAL

Cerebral Hemispheric Lesions.—The following group observations are indicative of the areas described.

Frontal Lobe (eleven cases):

1. Definite susceptibility to stimulation of the ear (ten of eleven).
2. Definitely good past-pointing after stimulation.
3. Absence of spontaneous vertical nystagmus.
4. Movements of the pelvic girdle good (poor in two only, but in those two the lesion extended toward the motor area).
5. Nystagmus after turning normal, or slightly exaggerated (never subnormal).
6. Vertigo usually normal, or slightly subnormal, never exaggerated.
7. Function of the vertical semicircular canal usually interfered with (seven of eleven cases).
8. Nystagmus of the horizontal canal usually not perverted (only three of eleven showed perversion).

Motor Area (ten cases):

1. Susceptibility to stimulation slight (only three cases).
2. Past-pointing good in all cases.
3. No spontaneous vertical nystagmus.
4. Movements of the pelvic girdle poor in all.
5. Nystagmus after turning good; rarely slightly exaggerated.
6. Vertigo after stimulation definitely diminished in all.
7. Function of the vertical semiciricular canals affected (nine of ten cases).
8. Nystagmus of the horizontal canal not perverted, only slightly so in two cases.

Temporal Lobe (six cases):

1. Susceptibility to stimulation absent.
2. Past-pointing practically normal in all, except one.
3. Spontaneous nystagmus absent, except in one.
4. Movements of the pelvic girdle good in four, poor in two—probable motor involvement in the latter.
5. Nystagmus after turning normal, or exaggerated.
6. Vertigo after turning, diminished in four, exaggerated in two.
7. Vertical semicircular canals unaffected, except in two.
8. Nystagmus of the horizontal canal not perverted.

An unusual feature was noted in two cases. The duration of vertigo after stimulation was tremendously prolonged.

Occipital Lobe (three cases):

1. Susceptibility to stimulation absent.
2. Past-pointing markedly exaggerated, in both extent and duration out of proportion to the vertigo.

3. No spontaneous nystagmus.
4. Movements of the pelvic girdle good.
5. Nystagmus after turning, normal.
6. Vertigo after turning normal; not diminished.
7. Vertical semicircular canals unaffected.
8. Horizontal nystagmus perverted.

While it is realized that in all the cases cited the lesion did not actually limit itself to the lobe designated, yet the greatest pathologic change was in the lobes considered. In some of the cases, however, the lesion definitely extended to more than one lobe, and of those the following were found:

Frontoparietal Lobe (two cases): The observations were about the same as in the frontal lobe, except that the movements of the pelvic girdle were poor in both cases.

Junction of the Temporoparieto-Occipital Lobe (four cases):

1. Susceptibility to stimulation absent.
2. Past-pointing uniformly good.
3. Spontaneous nystagmus absent.
4. Movements of the pelvic girdle good.
5. Nystagmus after turning, normal.
6. Vertigo normal, or slightly subnormal.
7. Vertical semicircular canals impaired.
8. Perversion of responses from the horizontal canals absent.
9. All vestibular fibers (vertical and horizontal canals) on the side opposite the lesion showed impairment or absence of function, with hearing on that side normal. As the lesion was located more posteriorly and became more definitely occipital, this characteristic became less evident in proportion.

Midcentral Lesions

Pituitary (eleven cases):

1. Susceptibility to stimulation varied. There was none in five cases, but it was present to an extreme degree in six cases.
2. Spontaneous past-pointing absent.
3. Spontaneous nystagmus absent, except to a slight degree in a few cases.
4. Movements of the pelvic girdle good.
5. Nystagmus after turning usually increased, although in four cases it was either normal or slightly diminished.
6. Vertigo generally speaking normal, or diminished. The number in which vertigo was definitely diminished was greater than those in which vertigo approached the normal.
7. Responses of the vertical semicircular canals was usually present.
8. Nystagmus of the horizontal canal not perverted.

Suprasellar, Including Lesions of the Corpora Quadrigemina, Pineal Body and Third Ventricle (eleven cases):

1. Patients were usually somewhat susceptible to stimulation of the ear, and in cases in which patients were clinically very sick, susceptibility was usually marked.

2. Past-pointing variable.

3. Spontaneous nystagmus absent.

4. Movements of the pelvic girdle poor.

5. Nystagmus after turning variable.

6. Vertigo and nystagmus not in proportion to each other.

7. Vertical semicircular canals, if interfered with at all, usually on one side only.

8. Nystagmus from the horizontal canal usually normal; in only three cases was it perverted.

When the lesion was high, as in the region of the pineal, or the corpora quadrigemina, evidence was sometimes found of involvement of the posterior longitudinal bundles noted by dissociated movements of the eyes followig stimulation of the ear.

SUBTENTORIAL

For the purpose of analysis, we divided these cases into lesions of the cerebellar hemispheric lobe, midline tumors, tumors of the cerebello-pontile angle and cerebellar tumors involving the angle secondarily.

Cerebellar Lobe (twenty-five cases):

1. Susceptibility to stimulation of the ear absent in all cases.

2. Past-pointing after stimulation poor in practically all cases with the exception of five, in which it was only fair.

3. Vertigo definitely diminished in all the cases, in some almost to the vanishing point.

4. Movements of the pelvic girdle poor in all cases; in the vast majority markedly poor.

5. Spontaneous vertical nystagmus definitely present only in thirteen cases; suspected in six, and absent in six.

6. Nystagmus after turning, increased in about one half of the cases; diminished in the other half.

7. The function of the vertical canals affected in half the cases, normal in the others.

8. Horizontal canals normal in half the cases, perverted in the others.

Midline Cerebellar (six cases):

1. Susceptibility to stimulation of the ear absent.

2. Past-pointing prolonged and fair in two; poor or absent in four.

3. Spontaneous vertical nystagmus present in all.

4. Movements of the pelvic girdle poor in all.

5. Nystagmus after turning exaggerated.

6. Vertigo normal in two, reduced in the others.

7. Vertical semicircular canals affected in all.

8. Nystagmus of the horizontal canal perverted in three.

In cases in which the pons was involved, there was a marked spontaneous nystagmus in all directions. The responses from the horizontal canals were apt to be markedly impaired, not perverted, and disassociation of eye movements following stimulation was present.

Cerebellopontile Angle Tumors (thirty-seven cases):

1. Susceptibility to stimulation of the ear absent.

2. Spontaneous past-pointing absent.

3. Vertical spontaneous nystagmus present in practically all of the cases.

4. Movements of the pelvic girdle poor in all cases.

5. Nystagmus after turning markedly diminished, but unequally as compared with turning to the right and turning to the left.

6. Vertigo markedly diminished, but unequally so as compared with turning to the right and turning to the left.

7. Responses from the vertical canals all absent, with the exception of two cases in which the responses were normal in one and slow in the other.

8. Horizontal canal usually showed perverted nystagmus on the side opposite the lesion.

9. Total loss of function—cochlear and vestibular—on the side of the lesion.

Cerebellopontile Angle Tumors Secondary to Cerebellar Involvement (four cases).—The notable difference between the responses obtained in patients with this type of lesion, and those obtained in patients with lesions of the cerebellopontile angle, was that the vertical canals on the side opposite the lesion showed some response in every instance. In addition, all these patients had evidence of cerebellar involvement, in that the vertigo was of short duration and the past-pointing, after stimulation, unusually poor.

DIFFERENTIAL DIAGNOSTIC SIGNS BETWEEN THE VARIOUS AREAS

A careful analysis of these various "phenomenon-complexes" will show that there is enough individuality in these group observations for the localization of lesions—marked in some, and less marked in others, but present frequently enough to enable the experienced examiner to arrive at a diagnosis. In the examination of patients with the vestibular tests, one encounters the same difficulties as would be encountered in an examination of these patients by any other method. Neurologic syndromes are also apt to vary and overlap. The first step in the diagnosis is to determine whether the lesion is supratentorial or subtentorial. The vestibular group observations for such a differentiation are quite definite. Having then placed the lesion, let us say supratentorially, one can take the frontal lobe complex as a standard from which to differentiate lesions

located elsewhere. A tumor of the occipital lobe is identified by the definitely prolonged and exaggerated past-pointing out of proportion to the vertigo after stimulation, and the absence of susceptiblity to the tests. Lesions at the junction of the parietotemporo-occipital lobe are accompanied by an impairment of all the vestibular fibers from the ear on the side opposite the lesion, and the patient is not susceptible to stimulation. In patients with lesions of the motor area, the movements of the pelvic girdle are poor, the vertigo after turning is apt to be unusually prolonged, especially if there is any extension of the lesion toward the temporal lobe, and there is slight if any susceptibility to stimulation. In a case of suprasellar lesion, the movements of the pelvic girdle are poor, the vertical semicircular canals, if interfered with at all, are usually affected on one side only, and vertigo and nystagmus are out of proportion to each other. In the presence of pituitary lesions, the vertigo after turning is usually of shorter duration than the nystagmus, the responses from the vertical semicircular canals are not usually interfered with and susceptibility to stimulation is apt to be absent, or, if present, is exceedingly marked.

Differentiation of the various subtentorial lesions reveals the most definite complex in patients with cerebellopontile angle tumors, namely, the loss of all responses on one side, including hearing, with a loss of the function from the vertical semicircular canals on the opposite side; whereas, in patients with lesions of the cerebellar lobe, both eighth nerves show presence of function with the other characteristics, namely, markedly impaired vertigo and past-pointing, poor movements of the pelvic girdle and loss of susceptibility to stimulation.

Whenever a difficulty arises between the clinical diagnosis of a suprasellar and cerebellar lesion, they can be differentiated by the vestibular tests as follows: a suprasellar lesion is accompanied by a fair degree of vertigo and past-pointing after stimulation and no spontaneous vertical nystagmus. Furthermore, patients with this type of lesion are always somewhat susceptible to stimulation of the ear, whereas those with a cerebellar lesion will exhibit just the opposite symptoms, such as definitely impaired vertigo and past-pointing, well developed spontaneous nystagmus and total immunity to stimulation of the ear.

CONCLUSIONS

1. A lesion of the brain usually causes abnormal reactions to the vestibular tests.

2. Generalized increased intracranial pressure, as such, cannot be diagnosed by the vestibular tests.

3. The vestibular observations indicative of the laterality of a lesion are definite and reliable, when present, but these signs are not exhibited in all cases of lesion of the brain.

4. The vestibular tests can usually differentiate definitely between a supratentorial and a subtentorial lesion.

5. Each anatomic area presents vestibular group observations of its own.

6. While in the vast majority of cases the diagnosis of tumors of the brain can be made by the vestibular tests, their value would be the greatest when taken in conjunction with the general clinical observations.

BASAL METABOLISM IN SCHIZOPHRENIA*

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The fact that more than one sixth of all hospital beds in the United States are devoted to victims of schizophrenia would seem to constitute this disorder the most insistent problem now confronting the medical profession. That it is receiving study, however, comparable in quantity or quality to that devoted to several disorders numerically less important can scarcely be maintained. When one considers the extent of present day medical research on such conditions as diabetes or cancer, it is astonishing that schizophrenia is relatively so much neglected. A comparison of any of the standard monographs on diabetes and on schizophrenia, for instance, brings out a remarkable discrepancy in the knowledge of the physical and metabolic conditions in the two disorders.

One of the most significant criteria of the functional state of the patient is his basal rate of oxygen consumption. Although the basal metabolism in persons with schizophrenia has been studied sporadically over a period of twenty years, little is known about it beyond the fact that it tends to a subnormal level. Neither the actual incidence of depressed rate nor the degree of depression has been determined in an adequate number of cases. From the data available, a correlation cannot be drawn with any degree of confidence between either the different types of schizophrenia or the clinical phase of any given type and the basal metabolism. In short, there is an outstanding need for the accumulation of a much greater mass of data recorded with due regard to the type and the stage of the disease.

Bornstein (1908[1]) studied twelve cases of schizophrenia including seven active cases and one case of catatonia in which recovery occurred and four cases of hebephrenic dementia praecox. In all of the first seven cases some degree of depression was noted, the range being from 22 to 6 per cent below normal. Four of the seven cases showed figures

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* From the Worcester State Hospital.

1. Bornstein, A.: Untersuchungen über die Atmung der Geisterkranken, Monatschr. f. Psychiat. u. Neurol. **24**:392, 1908.

below 90 per cent,[2] which conventionally delimits normality at its lower level. The case of catatonia in which recovery occurred showed a rate of 101 per cent. Of the four cases of hebephrenia two showed significant reductions—to 75 and 85 per cent, respectively—while two were within the normal range—98 and 107 per cent.

Frenkel (1909 [3]) added reports of three cases of hebephrenia, all of which showed basal rates within the normal range.

Gräfe (1911 [4]) reported a series of twelve cases in only four of which, however, were the patients in a "basal" condition. One of the remainder of the patients was sitting up, and the rest showed various degrees of restlessness or tension. In the four satisfactory cases, readings of 87, 88, 89 and 92 per cent were obtained. The others ranged from 92 to 118 per cent.

Bowman, Eidson and Burladge (1922 [5]) added reports of ten cases. In seven, the rate ranged from 69 to 88 per cent, and in three from 92 to 101.5 per cent.

Bowman and Grabfield (1923 [6]) studied five cases in which the basal metabolic rates varied between 63 and 97 per cent. Four of the five showed rates below 90 per cent.

Gibbs and Lemcke (1923 [7]) recorded eleven cases, in one of which, however, the patient was definitely not in a "basal" condition and in which the reading was 112 per cent. If this case is excluded the range in the other ten was from 68 to 99 per cent, seven being below 90 per cent.

Farr (1924 [8]) reported briefly on thirty-five cases: of these, thirteen gave readings below 90 per cent; sixteen between 90 and 110, and six above 110 per cent.

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2. In this paper, Langfeldt's (1926) method of designating metabolism in absolute percentage of the normal will be followed. Thus, 90 per cent is the equivalent of —10 per cent in the more common method of designation.

3. Frenkel: Ueber Untersuchungen des respiratorischen Stoffwechsels bei Psychosen, Psych. Verein z. Berlin, March, 1909, Neurol. Centralbl. **28**:443, 1909.

4. Gräfe, E.: Beiträge zur Kenntniss der Stoffwechselverlangsatmung (Untersuchungen bei stuporösen Zuständen), Deutsches Arch. f. klin. Med. **102**: 15, 1911.

5. Bowman, K. M.; Eidson, J. P., and Burladge, S. P.: Biochemical Studies in Ten Cases of Dementia Praecox, Boston M. & S. J. **187**:358, 1922.

6. Bowman, K. M., and Grabfield, G. P.: Basal Metabolism in Mental Disease, Arch. Neurol. & Psychiat. **9**:358 (March) 1923.

7. Gibbs, C. E., and Lemcke, Dorothea: Study in Basal Metabolism in Dementia Praecox and Manic-Depressive Psychoses, Arch. Int. Med. **31**:102 (Jan.) 1923.

8. Farr, C. B.: Results of Basal Metabolism Tests in One Hundred Mental Cases, Arch. Neurol. & Psychiat. **12**:518 (Nov.) 1924.

TABLE 1.—*Chief Observations in Thirteen Cases of Dementia Praecox, Simple Type*

Subject	Basal Metabolic Rate*	Outstanding Psychiatric Features
D. A., a man, aged 29; admitted to the hospital, January, 1927	93% P., 64 S.	Acute onset in 1924; alcoholic hallucinosis; "voice of God"; recovered but industrially inefficient; vagrant; arrested for carrying a revolver; now apathetic, confused and sits in distressing attitude; mind gradually clearing
M. E. D., a man, aged 27, admitted to the hospital, December, 1926	89% P., 62 to 68 F. S.	Acute hallucinosis a year before admission; same year developed apathy and became economic failure; now no voices
G. S. R., a man, aged 32, admitted to the hospital, June, 1927	93.5% P., 64 S.	Mother psychotic; two years before admission, after injury, became fearful of a gang plotting against him; voices and mind reading; now aggressive and euphoric; on visit
D. L., a man, aged 26, admitted to the hospital, January, 1927	92% P., 64 to 72	Foreigner, arrested for homosexual approach to boys; patient's ideas from God; apprehensive; tearful; hears bells; feels his mind is failing; gradual improvement
H. C. M., a woman, aged 25; one child; admitted to the hospital, April, 1927	100% P., 68 to 72 F. S.	Two years of recurrent depressions of few weeks' duration; year before admission, an acute hallucinatory experience with fear; later, some euphoria; hallucinations disappeared; quiet, indifferent
H. E., a woman, aged 35; two children; admitted to the hospital, January, 1927	88% P., 70 to 74 F. S.	Sister and children defective; mistreated children; was vagrant; gradual ideas of reference; delusions against Catholics; no hallucinations determined
B. A., a man, aged 26; admitted to the hospital, November, 1927	90% P., 58 to 62 F. S.	Peculiar child; neurotic, masturbator, alcoholism, gradual retardation, hallucinations, thievery
D. T., a man, aged 21; admitted to the hospital, April, 1928	86.5% P., 58 to 62 S	Vagrancy; change of temperament after army service; hallucinations, suggestible; intelligence quotient, 60; comfortably adjusted to hospital environment
D. C., a man, aged 39; admitted to the hospital, March, 1928	92.5% P., 64 S.	Normal childhood; quit work; irritable, seclusive, manneristic, moody, assaultive; probably homosexual; no marked deterioration
K. J., a man, aged 57; admitted to the hospital, October, 1915	93% P., 58 S.	Depressed; appearance filthy; relevant; hallucinated; no insight; gradual improvement; finally low grade mentality; poor judgment, foolish, timorous, no insight
N. C., a man, aged 29; admitted to the hospital, November, 1927	74% P., 40 to 48 S.	Normal boyhood; sensitive; poor judgment; no apparent heterosexual interest; argumentative; later sad; depressed, seclusive, self-absorbed; lives in dream world, without evidence of struggle or projection
O. J., a man, aged 35; admitted to the hospital, September, 1927	99% P., 60 to 68 F. S.	Parents alcoholic; normal childhood, except pavor; good workman, but peculiar; late development of sexual interests; arrested five times—drunkeness, assaultiveness; became queer, sullen, worried, depressed; at present dejected, discouraged, apathetic, without delusions or hallucinations; discharged on visit
H. B. R., a man, aged 27; admitted to the hospital, March, 1927	88.5% P., 48 to 54 F. S.	Peculiar parents; sudden onset at 18—ran away, careless in dress, influenced by dreams; vague ideas of persecution; apathy; no present hallucinations

Basal Metabolism:	
Range	74 to 100%
Average	91%
Number below 90%	5
Number above 110%	0
Number within normal range	8
Pulse Rate:	
Range (average)	44 to 72
Average	62

* In this table and in tables 2, 3, 4 and 5, S. indicates satisfactory determination; F.S., fairly satisfactory determination, and P., pulse rate during determination.

TABLE 2.—*Chief Observations in Twenty-One Cases of Dementia Praecox, Hebephrenic Type*

Subject	Basal Metabolic Rate	Outstanding Psychiatric Features
A. A. M., a woman, aged 34; admitted to the hospital, November, 1926	105% P., 82 to 88 S.	Long background of eccentric behavior, friction with people; three previous psychotic episodes; now feels electricity, sees God, is irrelevant and impulsive
C. E., a woman, aged 26; admitted to the hospital, January, 1927	72% P., 60 to 66 S.	Two years ago, delusions that employer loved her; excited; improvement; relapse; accuses sister of immorality, delusions recur; is silly, denies hallucinations
O. E., a man, aged 27; admitted to the hospital, November, 1923	100% P., 64 to 68 S.	Sleepless and depressed at 14; at 23, untidy, attitudinizing, incoherent; later, apathetic, manneristic, confused, grimacing, inaccessible, silly; now oriented
C. B. D., a man, aged 20; admitted to the hospital, January, 1927	100% P., 60 to 64 S.	Maternal uncle, aunt and cousins psychotic; year ago became peculiar, vaguely suspicious, excited, threatening, untidy; heard voices; now growing silly
A. H., a man, aged 32; admitted to the hospital, January, 1926	103.5% P., 54 to 58 P. S.	Delicate child; enuresis; masturbation, promiscuity, psycho-asthenia; later, hallucinations, delusions of sex failure, temporarily suicidal, gradual deterioration; institutional improvement; loss of hallucinations and delusions and some insight
A. A., a man, aged 23; admitted to the hospital, May, 1923	93% P., 63 to 66 S.	As a boy, masturbated a great deal; melancholy, downhearted, docile, very religious; became peculiar, loquacious; on admission showed psychomotor acceleration, later regression; destructive, assaultive, incoherent, hallucinations, unpredictable
C. V., a boy, aged 16; admitted to the hospital, January, 1928	84% P., 56 S.	Spoiled child; lovable; high school, two years—popular; became seclusive, sulky, stupid; then excited and unmanageable; now disintegrated, hallucinations; no evidence of conflict; disoriented; no insight; living in fantasy
D. J., a man, aged 23; admitted to the hospital November, 1921	91% P., 58 to 60 S.	Began day dreaming about fantastic inventions; arrested for theft; became indifferent, apathetic; occasionally destructive, irrelevant, incoherent; well oriented, passively cooperative and amiable; hallucinations; masturbates habitually; gradual drift toward dissolution
S. C., a man, aged 38; admitted to the hospital, May, 1927	88% P., 58 to 64 S.	Mulatto, farmer; shut-in personality, mother attachment, heterosexual failure, hallucinosis, brief catatonic excitement, rapid hebephrenic deterioration; now stationary
C. W., a man, aged 36; readmitted to the hospital, August, 1927	102% P., 66 F. S.	Farmer; became fearful of snakes and bears; talked to himself; unsteady at work; auditory hallucinations; at first destructive, filthy, talkative, oriented, in poor contact, memory good; now, irrelevant, incoherent, silly, without insight
G. A., a man, aged 26; readmitted to the hospital, April, 1928	88.5% P., 66 S.	Slow; mumbling; depressed; lazy; somatic delusions; contact, memory and orientation good; erotic accusatory dreams; now on visit
H. E., a woman, aged 35; admitted to the hospital, March, 1927	85% P., 68 to 70 S.	Silly and stuporous three months; delusion of poisoning; in hospital, seclusive, silly, given up to day dreams, taciturn, indifferent; orientation and memory good; inaccessible, rather disintegrated
Mc. O.C., a youth, aged 18; admitted to the hospital, March, 1927	94.5% P., 52 F. S.	Psychotic father; dull, run-away boy; gradual onset; antagonism, exhibitionism, voices; later, silly; now, apathetic, uncooperative
H. J., a man, aged 22; admitted to the hospital, May, 1928	88% P., 58 to 60 S.	Intermittently under custody for past seven years; noisy, indecent; no hallucinations; later, shut-in, silly, manneristic, hallucinated; then assaultive, preoccupied, seclusive, refusing to work; now, cooperative, in good contact, passively obedient, grimacing and silly, without insight
N. J., a man, aged 23; admitted to the hospital, August, 1927	84.5% P., 64 to 78 F. S.	Neurotic, sensitive child spoiled by mother; brilliant in school; never worked; no friends; gradual deterioration for nine years; now, silly, at times confused, euphoric

TABLE 2.—*Chief Observations in Twenty-One Cases of Dementia Praecox, Hebephrenic Type—Continued*

Subject	Basal Metabolic Rate	Outstanding Psychiatric Features
S. C., a man, aged 42; admitted to the hospital, February, 1924	94% P., 60 to 64 F. S.	Self-committed; hallucinated; dazed; depressed; good contact; introverted; later, bizarre hallucinations, disorientation, contact and judgment poor, no insight; now, out of contact hallucinations, irritable and aggressive
S. D., a man, aged 21; admitted to the hospital, January, 1928	79% P., 52 S.	Armenian factory hand; became hallucinated, quiet, quit work, suicidal, depressed, uncommunicative, somatic delusions, insomnia; finally silly, deteriorating
K. D., a youth, aged 17; admitted to the hospital, June, 1927	74.5% P., 60 to 68 S.	Selfish child; sleepwalker; masturbator in sleep; lazy; indifferent; gradual onset; noisy, impetuous, destructive, cruel, fear of death, refused food, abusive to mother; now, silly, evasive facetious, hears voices
S. H., a man, aged 29; admitted to the hospital, April, 1927	73% P., 52 to 56 S.	Aunt, sister, brother insane; two sisters defective; childhood tantrums; adolescent vagrancy; work deteriorated, vague fantasies of great success; suicidal; now, silly, indifferent, not hallucinated
A. L., a man, aged 21; admitted to the hospital, June, 1922	75.5% P., 48 S.	Shut-in childhood; at 15 became indifferent; later depressed, attempted hanging; voices; poor orientation; silliness, apathy
B. C. H., a man, aged 25; admitted to the hospital, December, 1925	85.5% P., 60 to 80 F. S.	Chorea at 10; sensitive, shut-in child; religious voices on admission; excited, silly; a runaway patient with episodic excitement; hypochondriacal

Basal Metabolism:	
Range	72 to 106%
Average	89
Number below 90%	12
Number above 110%	0
Number within normal range	9
Pulse Rate:	
Range (average)	48 to 86
Average	64.5

Walker (1924 [9]) reported a study of 30 cases: in half of these the rates were subnormal, ranging from 53 to 88 per cent.

Whitehorn and Tillotson (1925 [10]) recorded results in eleven cases. The rate of oxygen consumption ranged from 84 to 102.5 per cent, if one case of concurrent exophthalmic goiter in which the rate was 119 per cent is excluded. Of the ten uncomplicated cases, seven presented readings below 90 per cent and three within the normal range.

Bowman and Fry (1925 [11]) reported twenty-four cases in which the range was from 70 to 134 per cent. In eight, the readings were lower than 90 per cent; in fourteen, between 90 and 110 per cent, and in two, above 110 per cent.

9. Walker, J.: Basal Metabolism in Mental Disorders, Especially Dementia Praecox and the Influence of the Diathermic Current on the Same, J. Ment. Sc. **70**:47, 1924.

10. Whitehorn, J. C., and Tillotson, K. J.: Oxygen Consumption in Dementia Praecox, Boston M. & S. J. **192**:1254, 1925.

11. Bowman, K. M., and Fry, C. C.: Basal Metabolism in Mental Disease, Arch. Neurol. & Psychiat. **14**:819 (Dec.) 1925.

TABLE 3.—*Chief Observations in Twenty-Three Cases of Dementia Praecox, Catatonic Type*

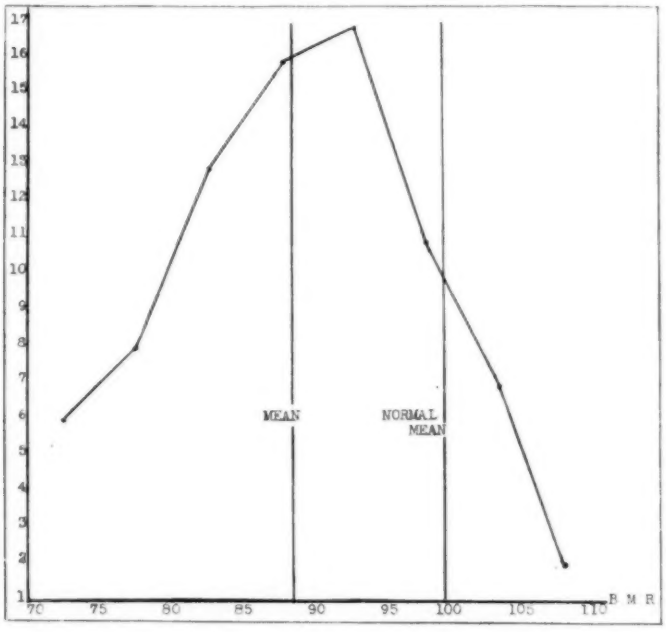
Subject	Basal Metabolic Rate	Outstanding Psychiatric Features
I. D., a man, aged 38; admitted to the hospital, October, 1923	84% P., 52 S.	Italian laborer; no education; alcoholic history; in 1922, thought women were making advances and that the Portuguese were after him; shot a stranger as one of his persecutors; assumed attitudes; became suddenly talkative and violent, then mute for one year
M. G., a man, aged 29; admitted to the hospital, October, 1922	94% P., 62 to 68 S.	All of family have court records for drunkenness; suddenly became excited and hallucinations; delusions of persecution; later became silly; sang frequently; assumed attitudes; for past two years has been mute
S. H. C., a man, aged 27; admitted to the hospital, May, 1927	85% P., 48 to 50 F. S.	Conflict with stepmother; youthful immorality; sudden catatonic episode in 1920; again in 1925, of brief duration; again before admission; recovery without memory or insight; shallow, lazy but selfsupporting
B. A., a man, aged 23; admitted to the hospital, January, 1927	84% P., 60 to 72 F. S.	Asthma at 2; sudden onset; restless; destructive; refusing food; grimacing; impulsive; manneristic; now, quiet, recovered without insight
H. L. T., a man, aged 28; admitted to the hospital, November, 1926	97.5% P., 60 to 64 F. S.	Two brothers had convulsions; two injuries of the head during adolescence; episode of untidiness, seclusiveness in adolescence; before admission, excited, in pain, wants to be clean; apprehensive; bizarre voices and visions; assaultive; stuporous; now, mind clearing, forgets hallucinations, occasional violence
B. P. W., a man, aged 41; admitted to the hospital, February, 1927	103.5% P., 60 to 68 F. S.	Father, sister, brother, aunt psychotic; fond of mother, avoided girls; feared wronging mother; feared insanity; sudden onset with demonstration of love for mother; quickly became apathetic; hearing God's voice; assaultive; mute, becoming agitated and suspicious
J. A., a man, aged 22, admitted to the hospital, September, 1927	80.5% P., 66 to 70 S.	Normal child, except sensitive about stammering; many friends; became seclusive, fantasied, uninterested; worrying, then overtalkative, overactive, grimacing and incoherent; later, neat, mute, immobile, out of contact, rigid, negativistic
K. J., a man, aged 23; admitted to the hospital, February, 1928	86% P., 60 S.	Sensitive, modest, high grade student, overconscious, mother fixation; then restive, assaultive, stupid, untidy, tube-fed; final outcome showed condition as "benign stupor"
M. G., a man, aged 29; admitted to the hospital, January, 1925	95% P., 76 to 78 S.	Normal childhood; bright but trifling; normally heterosexual; pleasing personality; became suspicious, surly, with auditory hallucinations; orientation good; irrelevant, impaired memory; poor insight; suspicious, psychomotor retardation; later, confused, hallucinated, spoon-fed, manneristic; finally, completely blocked and hallucinated
M. D., a man, aged 23; admitted to the hospital, September, 1927	107% P., 68 to 78 F. S.	Lazy; seclusive; unambitious; no apparent heterosexual interest; then, insomnia, excitement, assaultive; on admission, uncommunicative, uncooperative, blocked, no insight, antagonistic, sullen, day-dreaming
R. A., a man, aged 22; admitted to the hospital, March, 1923	85% P., 58 to 62 S.	Tantrums as a child, much teased, seclusive, peculiar; one testis not palpable, one soft; on admission, apathetic, childish, orientation good, no delusions, no insight; later, hallucinations, period of acute catatonic excitement, considerable blocking
S. F., a man, aged 34; admitted to the hospital, November, 1924	76% P., 64 S.	Seclusive, shy, bright in school; marriage happy; somewhat amorous; became mute, staring, engrossed, gloomy, suspicious, irritable; orientation and memory good, contact good; ideas of special guidance; ideas of influence; stiff attitude, day dreaming; in contact, apparently hallucinated; considerably blocked; marked improvement under thyroid therapy

TABLE 3.—*Chief Observations in Twenty-Three Cases of Dementia Praecox, Catatonic Type—Continued*

Subject	Basal Metabolic Rate	Outstanding Psychiatric Features
S. A., a man, aged 25; admitted to the hospital, May, 1928	95.5% P., 46 to 48 F. S.	Normal childhood, good student; normal heterosexual contacts; masturbation; worry about health at 18; became dreamy, out of contact, manneristic, stereotyped; showed unmotivated laughter; found naked and mute; negativistic, uncooperative, untidy, anxious, erotic, ideas of death and of reference; somatic delusions; periods of improvement
U. E., a man, aged 24; admitted to the hospital, December, 1927	83% P., 60 to 66 S.	Spoiled child, mendacious and pestering; heterosexual interest for only one girl with whom strong attachment was broken, followed by depression, worry over masturbation; became timorous with ideas of persecution and suicide; blocked; muttering; seclusive; day dreaming; insight and judgment poor; uncooperative; at times mute and negativistic; apparently hallucinations; disoriented; fecal incontinence at night; partial improvement toward hebephrenic picture
B. S., a man, aged 29; admitted to the hospital, April, 1927	105% P., 94 to 100 S.	Normal child but selfish; bright, studious, musician; high principles; became unsociable and seclusive, depressed; temporary recovery; then dull, absent minded; later, irritable, threatening, untidy, lethargic; then negativistic, dreamy, typical catatonic stupor, tube-fed, deluded; little insight, defective judgment, fair memory
B. E., a man, aged 20; admitted to the hospital, May, 1927	95% P., 64 to 68 S.	Mother attached; nail biting; slow in development; alcoholic; nervous; became hallucinated with somatic delusions; sleepless; self-accusatory; ran away nude; on admission, mute, negativistic, confused, disoriented; later, excitable, assaultive; then apathetic, blocked, emotional deterioration, memory fair, insight poor, tendency to verbigeration
S. F. G., a man, aged 25; admitted to the hospital, April, 1925	71% P., 58 S.	Brother catatonic; sudden onset; thought deprivation; weakness; attitudinizing; mute; tube-fed; slow improvement
C. N., a man, aged 27; admitted to the hospital, December, 1927	85.5% P., 76 to 78 S.	Father schizoid; delicate child; excelled in poetry; began to read psychoanalytic literature; three years before admission became assaultive; bizarre in his remarks; now bizarre in conduct, some anxiety, hears voices continually
R. P., a man, aged 48; admitted to the hospital, April, 1924	92% P., 40 to 44 S.	Sister insane; twenty years before admission, patient stopped work, refused to talk to members of family, cried often; stood for hours in one position; mute for years; does little odd jobs on ward; never excited; refuses cigarets, makes own with newspapers
A. L., a man, aged 24; admitted to the hospital, January, 1926	96.5% P., 54 to 60 S.	Sudden onset four years before admission; refused food; resistive; cataleptic; retained saliva; voices; improved and sent from hospital
T. C., a youth, aged 20; admitted to the hospital, April, 1927	82% P., 64 to 70 S.	Psychotic parents; sensitive, religious child; depression over love affair; visions; restless, anxious, violent at times, attitudinizing
A. E., a woman, aged 27; admitted to the hospital, December, 1926	96% P., 68 to 88 F. S.	Previous voluntary admission; on second admission, made sign of cross, heard voices; on third admission, sudden excitement, disorientation; later, became mute, then improved
R. D., a man, aged 25; admitted to the hospital, August, 1924	88.5% P., 54 to 56 S.	Maternal uncle psychotic; spoiled child; suicidal episode; heard voices from heaven; was negativistic; improved; discharged; returned mute, apathetic, oriented

Basal Metabolism:	
Range	71 to 105%
Average	90%
Number below 90%	12
Number above 110%	0
Number within normal range	11
Pulse Rate:	
Range (average)	42 to 97
Average	64

Langfeldt (1926 [12]) made what is perhaps the most adequate study yet offered. His series included forty cases, of which sixteen of the subjects were catatonic, eleven hebephrenic and thirteen "mixed." In eight of the patients with catatonia the disease was in an acute stage. In six of these there was a reduction in the basal rate, the range being from 76 to 85 per cent. In the other two the range was within normal limits. The other eight catatonic patients who were in a quiescent phase, though showing more or less muscular rigidity, gave rates within conventional normal limits. Of the thirteen hebephrenic patients, only



Frequency curve of basal metabolic rate in eighty cases of dementia praecox grouped by 5 per cent increments.

one showed a significant reduction, namely, to 76 per cent. The range in the remainder of this group was from 97 to 113 per cent. In the thirteen "mixed" cases, the range was from 72 to 120 per cent. Of the total thirteen, three acute and three quiescent cases showed rates below 90 per cent. All of the subjects in this group of mixed cases who showed depressions below 90 per cent were regarded by the author as predominantly catatonic.

12. Langfeldt, G.: The Endocrine Glands and Autonomic Systems in Dementia Praecox, Bergen, J. W. Eides Boktrykkeri, 1926, p. 326.

Bowman (1927 [13]) added reports of twenty-three cases in eleven of which the rates were below 90 per cent. Of the remaining twelve cases, in all but two, one or more readings below 100 per cent were obtained. The extreme range in this series was from 62 to 106 per cent or, what is more accurate, if the lowest reading obtained on each patient is taken, from 62 to 102 per cent.

Altogether, then, we have been able to find reports on 206 cases. The extreme range in the basal metabolic rate was from 53 to 134 per cent. Of the 206 subjects, ninety-four gave readings below 90 per cent, ninety-seven between 90 and 110 per cent, and fifteen above 110 per cent. The data are neither numerous nor homogeneous enough to justify any attempt at formal statistical treatment.

METHODS

During the past year and a half, we have been making somewhat intensive studies of metabolic conditions in patients with dementia praecox. In eighty patients we have been able to obtain fairly or entirely satisfactory determinations of the basal metabolic rate. The readings were obtained by the use of a Benedict closed circuit apparatus operated by a well trained and conscientious technician who is used to dealing with psychotic patients.

A rubber mouthpiece and nose-clip were used to make the connection between the patient and the metabolimeter. Careful watch was kept that leakage around the mouthpiece did not occur. It is believed that with psychotic patients more reliable readings can be obtained in this way than by the use of a face or head mask with its inevitable tendency to excite the patient.

It is thought that the readings are as accurate as can be hoped for with schizophrenic patients and with an apparatus of the type used. Aside from the crass errors of using spent soda lime and of allowing leakage around the mouthpiece with the motor "speeding," all significant technical errors in the oxygen consumption method displace the readings in an upward direction. The lowest rate obtained, therefore, was used in each case in tabulating the data for publication. The results in each case were calculated to the Harris-Benedict and the Aub-Du Bois standards and the means of the two values taken.

The outstanding difficulty in making determinations of the basal metabolic rate in schizophrenic patients is the obvious one of securing adequate cooperation. Any tenseness or movements of the patient cause the readings to range above the true basal rate. As many as ten

13. Bowman, K. M.: Endocrine and Biochemical Studies in Schizophrenia, J. Nerv. & Ment. Dis. **65**:465, 1927.

TABLE 4.—*Chief Observations in Fifteen Cases of Dementia Praecox, Paranoid Type*

Subject	Basal Metabolic Rate	Outstanding Psychiatric Features
C. C., a man aged 22; admitted to the hospital, April, 1928	89.5% P., 52 S.	Insidious onset; ideas of persecution; auditory hallucinations and delusions; became tense, lacrimose and threatening; ideas of reference and influence; firmly entrenched pattern of concealment with superficial selfpossession and composure
H. R., a man, aged 39; admitted to the hospital, September, 1924	88% P., 58 S.	Mother fixation; feeling of guilt from masturbation; ideas of persecution and of wrong doing, with feeling of sexual impotence; no ideas of grandeur or hatred; hallucinations; later, gloomy, preoccupied, inaccessible, deteriorating
M. E., a man, aged 34; admitted to the hospital, August, 1917	94.5% P., 62 to 68 S.	Become worried; refused to eat; ideas that people wish to shoot him; agitated; threatening; seclusive; dejected; hints at suicide; ideas of reference, persecution; fears of impending harm; later, indifferent, idle, some failure of memory; gradual regression toward simple type
S. G., a man, aged 54; admitted to the hospital, October, 1918	75.5% P., 58 F. S.	Gradual onset; ideas of persecution; assaultive; hallucinative; deluded; became mute, dejected, slovenly, oriented; memory good; some insight; poor judgment; some blocking; finally untidy, silly, apathetic, disoriented, questionable hallucinosis, mute
S. J., a man, aged 46; third admission to the hospital, July, 1925	94% P., 48 F. S.	Very religious; never held job; always persecuted; very "superior"; seclusive; boastful; quarrelsome; later, feeling of cosmic identification and great power; some degree of self respect retained by delusional misinterpretation; now, in state of deep regression with well fixed paranoid delusional system
R. C., a man, aged 36; admitted to the hospital, October, 1926	103% P., 48 to 56 F. S.	Lost arm at 14; bright at school; violent temper, became terrified, agitated, sleepless; in hospital, varied from terrified weeping to contentment; cooperation variable; evasive; orientation and memory good; occasional hallucinations; insight and judgment impaired; marked delusional misinterpretations
P. D., a man, aged 30; admitted to the hospital, August, 1927	92% P., 48 S.	Normal childhood; at 26, became vagrant; sexual promiscuity; stubborn, seclusive, ill tempered; became restless; delusions of persecution; unmotivated laughter; disobedient; obsessed with sex; committed assault on girl; orientation and memory good; speech relevant and coherent; cooperative; dependable; much concerned with religion and persecutions; pronounced delusional system with relative intellectual integrity
J. A. F., a man, aged 37; admitted to the hopsital, February, 1926	81.5% P., 48 to 56 S.	Fifteen years before admission, gradual onset of delusions against wife; six years before admission came voluntarily to hospital; year before admission, confused, careless, poorly oriented; now, quiet, tidy, vaguely paranoid
F. T. J., a man, aged 32; admitted to the hospital, March, 1926	86% P., 52 to 54 S.	Onset two years before admission; recurrence one year before admission of voices to murder his mother, and accusing of sex perversions; bizarre delusions, uncooperative but tidy
C. G. L., a woman, aged 37; admitted to the hospital, December, 1925	96% P., 56 to 64 S.	Increasing delusions for past eight years of husband's infidelity; had "electricity in her mind" and was "three persons in one"; irritable, well oriented
M. D., a man, aged 33; second admission to the hospital, February, 1928	87% P., 70 S.	Enuresis until 7, dull in school; industrious; quit work because of "persecutions"; moved frequently; ideas of reference; threatening to kill tormentors and himself; first commitment, depressed, hallucinated, clear, quiet; on readmission, had ideas against physicians and government; somatic delusions; now, clear, silly, deluded, cooperative, at times apathetic, without insight, apparently hallucinated
S. B. C., a man, aged 40; admitted to the hospital, January, 1927	95.5% P., 54 to 56 S.	Gradual economic failure, becoming excitable, euphoric, bizarre, with ideas of importance and persecution; quiet conduct

TABLE 4.—*Chief Observations in Fifteen Cases of Dementia Praecox, Paranoid Type—Continued*

Subject	Basal Metabolic Rate	Outstanding Psychiatric Features
T. F. W., a man, aged 34; admitted to the hospital, May, 1927	95% P.; 62 to 64 S.	Psychotic family history; three months' excitement at 18; never well after war; gradual system of delusions against his mother; bizarre ideas; denies hallucinations which are evidently present; uncooperative, surly
J. P., a man, aged 37; admitted to the hospital, January, 1923	80% P., 64 to 66 S.	Grandmother a suicide; aunt insane; cousin insane but recovered; father odd; patient always seclusive; sergeant in regular army; at 23 heard voices, felt persecuted; committed at 25; at 32, colon resection; slight improvement, then relapse with gradual deterioration
T. E. J., a man, aged 30; admitted to the hospital, June, 1924	85.5% P., 54 to 58 S.	Uncle insane; frail, sensitive child; eight years before admission, was insulting to friends; delusions of persecution increased; now feels exhausted; occasional outbursts of distractiveness

Basal Metabolism:	
Range	75 to 103%
Average	89%
Number below 90%	8
Number above 110%	0
Number within normal range	7
Pulse Rate:	
Range (average)	48 to 70
Average	58

rehearsals have been required in the cases of individual patients, and often not entirely satisfactory conditions of quietude have been obtained even then.

RESULTS

Although not enough cases are included to permit valid deductions, the data may for convenience be considered under each of the diagnostic headings, such as simple and hebephrenic. The significance of this differential treatment is limited, moreover, by the fact that the classification is more or less arbitrary in numerous cases which were actually on the borderline between two groupings. In some, too, the psychoses were rather ill defined at the time of study. For instance, various subjects cataloged as catatonic had regressed more or less to a hebephrenic or a simple level. In the series as a whole, however, the relative smoothness of the distribution curve indicates that the addition of further cases would probably not greatly alter the frequency of cases falling in the various percentage groups.

In the simple type, five of thirteen readings were below the normal limit, with a mean value of 91 per cent. In the hebephrenic type, twelve of twenty-one readings were below 90 per cent with a mean value of 89 per cent. The readings of twelve of twenty-three catatonic patients fell below 90 per cent, and the mean value of twenty-three cases was 90 per cent. Fifteen cases were classified as paranoid. In eight the rate was below normal. The mean in this group was 89 per cent. Six of eight mixed types showed rates below 90 per cent, with a mean value of 84 per cent.

TABLE 5.—*Chief Observations in Eight Cases of Dementia Praecox, Mixed Type*

Subject	Basal Metabolic Rate	Outstanding Psychiatric Features
A. C., a man, aged 29; admitted to the hospital, May, 1927	80% P., 80 to 84 S.	Psychotic stock; only child; family discord; mother attachment; late sexual awakening; acutely catatonic over mother; then occasionally impulsive and responsive; usually apathetic; silly, deteriorated, hallucinations
F. J., a man, aged 30; admitted to the hospital, June, 1927	105% P., 64 to 68 S.	Convulsions in childhood; conduct became bizarre; unmanageable; ideas of persecution; assaultive and destructive; jealous; now, fair contact, silly; orientation correct; memory intact; often irrelevant and incoherent; finally deep regression, with ugly suspicious attitude; schizophrenic type of conversation and attitude of evasion and concealment
F. A., a man, aged 27; second admission to the hospital, March, 1928	78% P., 54 to 60 S.	Insidious onset; diagnosed feebleminded at 9; hospitalized six years; on admission, mute, passive, unemotional; later, tidy, uncommunicative, passively obedient, withdrawn, day dreaming, foolish, judgment defective; finally, deteriorated, mute, comfortable, silly and friendly
S. A., a man, aged 20; admitted to the hospital, May, 1928	80.5% P., 48 to 54 F. S.	Spoiled child; meticulous, interested in books; became melancholy, self-depreciatory, seclusive; later, silly, impulsive, assaultive; at admission, shows catatonic-like movements, playfulness, hallucinations, distractibility, irritability, manneristic, at times obscene; talkative, elated; insight and judgment poor
Z. L., a man, aged 25; admitted to the hospital, July, 1927	70.5% P., 67 S.	School record satisfactory; worked three years; few friends; restricted interests; no vices; sensitive, bashful, generous, conscientious, religious; much sex fantasy; became quiet, then assaultive; on admission, uncommunicative, apathetic, inactive, later showing some interest; memory and orientation good; speech slow; relevant; coherent; some insight, passively cooperative; fantasy has become reality
K. C. E., a man, aged 29; admitted to the hospital, December, 1926	93% P., 56 to 60 S.	At 22 began character changes, inefficiency, seclusiveness, alcoholism, irregularity, promiscuity; on admission heard voices, was impulsive; became quiet, surly, indifferent; suicide by hanging
N. G. W., a man, aged 23; admitted to the hospital, March, 1926	77% P., 58 to 66 S.	Psychoses in both sides of family; patient peculiar, sensitive; catatonic episode and committments in 1924 and 1926; silly between episodes, mute, depressed, hyperreligious episodes; hallucinations, stilted, inefficient
P. A. J., a man, aged 31; admitted to the hospital, March, 1927	80% P., 52 to 58 S.	Dull child; hysterical anesthesia at 24; at 29 heard voices and saw colored birds in room; voices ordered assault on wife, which he made; improved in hospital

Basal Metabolism:	
Range	70.5 to 105%
Average	84%
Number below 90%	6
Number above 110%	0
Number within normal range	2
Pulse Rate:	
Range (average)	52 to 82
Average	62+

TABLE 6.—*Distribution of Metabolic Rates in Eighty Patients with Dementia Praecox*

Basal Metabolic Rate	Simple	Hebephrenic	Catatonic	Paranoid	Mixed	Total
From 70 to 75%	1	3	1	..	1	6
75 to 80%	..	2	1	2	3	8
80 to 85%	..	3	7	2	1	13
85 to 90%	4	4	3	4	1	16
90 to 95%	4	4	4	4	1	17
95 to 100%	4	1	4	2	..	11
100 to 105%	..	3	2	1	1	7
105 to 110%	..	1	1	..	..	2
Total	13	21	23	15	8	80

Of the eighty cases, forty-three, or 56 per cent, fell below the conventional 90 per cent which marks the lower level of normality. The remaining thirty-seven cases (46 per cent) all fell within the normal range of 100 ± 10 per cent. It is to be emphasized that no case was studied in which, with careful repetitions of the test, a reading below 110 per cent was not secured. The mean value for the whole series is 89.1 per cent. The extreme range was from 71 to 106 per cent.

As one criterion of the actual normality of the basal condition, the pulse rate obtaining during the determination is recorded. In most instances the extreme range is noted, but in some only the average for the time during which the rate was being recorded is noted. The extreme range of the pulse rate was from 42 to 86, with a mean

TABLE 7.—*Distribution of Basal Metabolic Rates in Two Hundred and Eighty-Six Patients with Dementia Praecox*

	Below 90%	90 to 110%	Above 110%	Total
Bornstein (1908)	6	6	..	12
Frenkel (1909)	..	3	..	3
Grafe (1911)*	3	1	..	4
Bowman et al. (1922)	7	3	..	10
Bowman and Grabfield (1923)	4	1	..	5
Gibbs and Lemcke (1923)	7	2	1	10
Farr (1924)	13	16	6	35
Walker (1924)	15	13	2	30
Whitehorn and Tillotson (1925)	7	3	..	10
Bowman and Fry (1925)	8	14	2	24
Langfeldt (1926)†	13	23	4	40
Bowman (1927)†	11	12	..	23
Hoskins and Sleeper (1928)	43	37	..	80
Total	137	134	15	286

* Excluding all cases recorded as being in a "basal" condition.
† Tabulating lowest values recorded in each case.

value of 61.1. Whether this relatively low pulse rate has the same significance as the reduced basal metabolic rate, i.e., general depression of cell activity, or whether it indicates a high incidence of so-called vagatonia, has not been determined. The comparative rates of reduction in the two cases, however, would point rather to the first mentioned interpretation.

COMMENT

Just how much allowance should be made for lack of quiescence in evaluating data from this type of patients has not been accurately determined and could be determined only by an elaborate study involving the psychogalvanic reflex, muscular tonicity, and the like. It can only be stated that the readings recorded in our own and other studies undoubtedly tend to range above the true basal rate. This gives added weight to the low trend recorded.

That many of the patients studied are leading a sedentary life demands consideration. It seems to be the general impression that such

an existence lowers the basal metabolic rate. That exercise per se raises the rate, however, is doubtful. From a careful analysis of the literature and from rigorously controlled experiments on dogs, Steinhaus (1927 [14]) did not find valid evidence that exercise actually does augment the basal metabolism.

There is an impression, too, that the basal rate is lower in summer than in winter. In view of the fact that schizophrenic patients are to a considerable extent kept in well heated rooms during the colder months, their basal metabolic rates would presumably be the same as those of the summer season. Gustafson and Benedict (1928 [15]), however, have found that the tendency is for the rates to be slightly higher in summer than in winter. Altogether, then, it is probable that the rates recorded in our own and in similar studies are neither significantly raised nor lowered by the sedentary, protected life of the patients.

SUMMARY

Reports of eighty cases have been added to the 206 instances of determination of basal metabolic rate of persons with schizophrenia found in the literature.

In our series the extreme range was from 71 to 106 per cent, with a mean value of 89.1 per cent. In the eighty cases, the range in forty-three, or 56 per cent, fell below the conventional lower limit of normality.

The pulse rate ranged from 42 to 86, with a mean value of 61.1.

Of the total 286 cases cited, in 137, or 47.9 per cent, the basal rate was below 90 per cent.

The basal metabolic rate in persons with dementia praecox averages characteristically more than 10 per cent below normal.

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14. Steinhaus, A. H.: Studies in the Physiology of Exercise: I. Exercise and Basal Metabolism in the Dog, Am. J. Physiol. **83**:658, 1927.

15. Gustafson, Florence, and Benedict, F. G.: The Seasonal Variation in Basal Metabolism, Am. J. Physiol. **86**:43, 1928.

ELECTRONYSTAGMOGRAPHY

A GRAPHIC STUDY OF THE ACTION CURRENTS IN NYSTAGMUS*

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Graphic records of the movements of the eyes in nystagmus can be obtained by means of the electrocardiograph. The records, like the electrocardiogram, are based on the fact that a muscle under the influence of a stimulus, including a nerve impulse, is traversed by a wave of negativity, the so-called action current, immediately preceding its contraction. The current, if led off through a string galvanometer, produces a deflection of the suspended thread between its magnetic poles, the direction of the deflection varying with the direction of the current. A photograph of the deflection when obtained on a moving film thus furnishes a record not only of activity in the muscle but of the origin and course along which the current is propagated. The current flows from the point of higher to that of lower potential and, accordingly, the point at which it enters the galvanometric arc of the circuit is designated the positive pole and the point at which it leaves this arc the negative pole. These poles, however, have each a directly opposite function in their relation to the course of the current through tissues of the body, more specifically, the acting muscles, in which part of the circuit the current flows in the exactly opposite direction.

In horizontal as well as in rotary nystagmus, the eyes move conjugately in one or its diametrically opposite direction. They do this not only in nystagmus to the different poles of the plane but during each cyclic process of the phenomenon, a composite process consisting of a slow movement of the eyes in one direction which is immediately followed by a quick movement in the opposite direction. Antagonistic groups of muscles are thus affected in these different types of movements of the eyes, the resulting flow of current varying with the position and direction of the groups of muscles in action. It can therefore be observed that in a person with nystagmus, if the temples on the two sides of his body—essentially bony structures which as depositories of inorganic salts form an excellent conductor of the electric current—are connected with the electrocardiograph, allowing the action currents from the contracting muscles of the eyes to be led off through the string galvanometer, a characteristic record is obtained which shows a distinctive curve

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* Read at the Annual Meeting of the Pacific Coast Oto-Ophthalmological Society, Santa Barbara, Calif., April 18, 1928.

for each type of movements of the eyes. (It is to be noted that when the electrodes are applied to the temples the circuit is completed distally to the sphere of action of the heart muscle and is consequently unaffected by the action current from this organ.)

At my suggestion that a possible way be found whereby nystagmus could be recorded by the electrocardiograph, Dr. Phebus Berman, in charge of the Electrocardiographic Laboratory at the Los Angeles County General Hospital, has developed the following method and technic. Every record in this article was taken by him personally. The following is his description of the technic. The apparatus used was a Hindle electrocardiograph with an arc light equipment.

The electrodes, about 3 inches (7.6 cm.) in diameter, were made of block tin shaped like a horseshoe. They were covered with rubberized cloth on the outside and several thicknesses of gauze wet in saturated saline solution on the side near the skin. The patient's face was washed with soap and warm water, and the electrodes were applied to the temples with the open side of the horseshoe toward the eyes, extending for about 1 inch (2.5 cm.) on the forehead above and the malar prominence below. The electrodes were held in place by bandages secured tightly around the upper part of the head and face.

In all records, unless otherwise stated, the right electrode (the one usually applied to the right arm in electrocardiography) was placed over the right temple. The other was applied to the left temple. All deflections of the string recorded above the base line, therefore, indicate negativity of the right side of the head and represent an electrical current passing in the patient from the right to the left and continuing from the left temple through the galvanometer and completing the circuit at the right temple. All deflecions of the string recorded below the base line represent an electrical current in the opposite direction.

In all records, unless otherwise stated, the string of the galvanometer was slackened and calibrated so that it would deflect 2 cm. for each millivolt of current introduced. This was done in order to magnify the excursion of the string caused by the feeble electrical current. An excursion of 1 mm. above the base line represents an electromotive force of 0.00005 volts.

In most records, the skin resistance measured between 3,000 and 4,000 ohms. As a rule the resistance was not high, and in a few records it was almost nil. The patient was instructed to place himself in a state of complete relaxation, and to keep his eyes closed during an experiment. This was done in order to eliminate as far as possible any currents from the action of other muscles.

INTERPRETATION OF THE RECORDS

To enable one to interpret a record of nystagmus, it is well to note first the graphic representation by this method of movements of the eyes carried out voluntarily (figs. 1 *B* to 1 *E*, and 2 *B* to 2 *E*). It will be seen from figure 1 that movements of the eyes "to the right" (movements which were initiated by a deviation of the eyes from a fixed, primary position in the midline to the extreme right, figure 1 *B*) are indicated by waves, semiquadrangular in shape, below the abscissa, and that movements of the eyes "to the left" (movements which were initiated by a

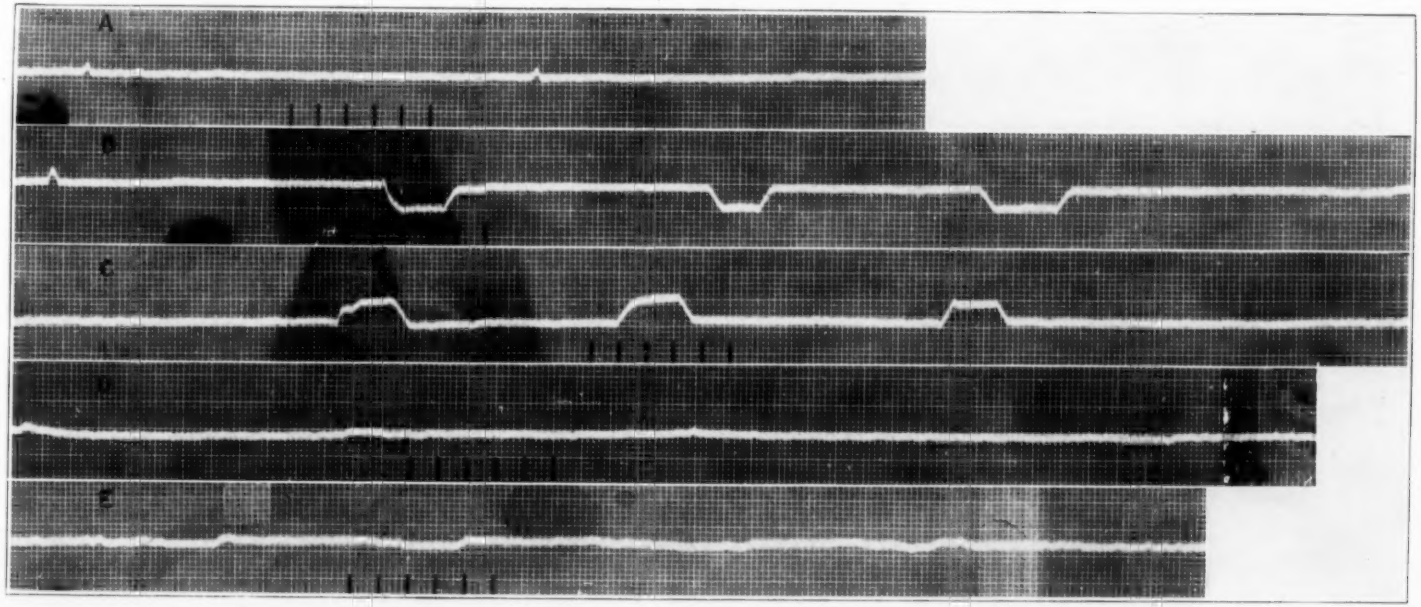

Fig. 1.—Electromyograms of voluntary movements of the eyes by a normal person with electrodes applied to the temples. *A*, looking straight ahead; *B*, looking to the right; *C*, looking to the left; *D*, looking up, and *E*, looking down. In this figure and in figures 2, 3, 4, 5, 6, 7, 9 and 10, the time marks indicate one-fifth of a second.

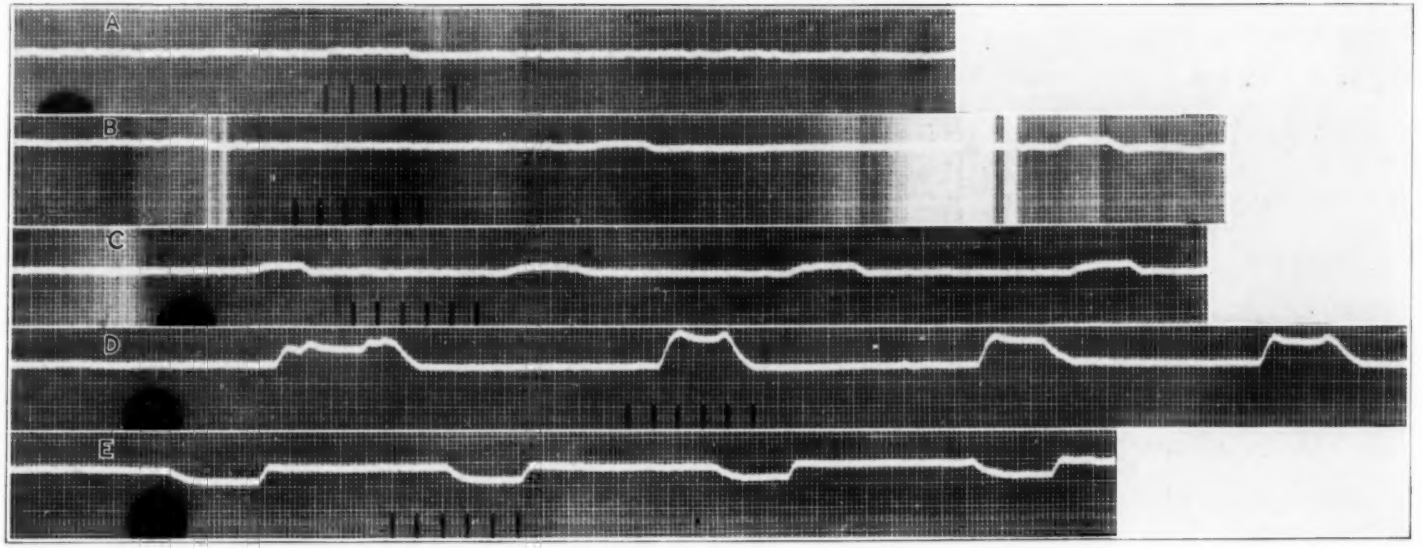

Fig. 2.—Electromyograms of voluntary movements of the eyes by a normal person, with "left" electrode above left eye and "right" electrode over superior maxilla. *A*, looking straight ahead; *B*, looking to right; *C*, looking to left; *D*, looking up, and *E*, looking down.

deviation of the eyes to the left, figure 1 *C*) are indicated by similar waves above the abscissa. The waves are seen to be composed of three phases: a downstroke which is followed by a pause and then an upstroke in movements of the eyes "to the right," and an upstroke, followed by a pause which in turn is followed by a downstroke, in the case of movements of the eyes "to the left."

The first phase, somewhat olbique in direction and having a duration of about one-twelfth or one-tenth of a second, represents the primary deviation of the eyes from the midline. The pause, varying in duration and representated by a horizontal line, is the period during which the eyes are held in their deviated position. The third phase, represented by a wave which is similar in character and duration to that of the primary phase, is the period during which the eyes return to their original position. It will be noted that the wave of the third phase representing, as it does, a relaxation of the contracting muscles, extends only to the abscissa and does not go beyond it.

The records show further that with the electrodes on the temple, movements of the eyes in the vertical plane (i.e., up and down), provided, of course, that they are not associated with movements laterally, are not accompanied by a definite flow of current through the galvanometer. Such movements are, however, indicated by large waves similar in character to the waves obtained from movements of the eyes in the horizontal plane, if the electrodes are applied in the vertical plane and in such a manner as to have the eyes between them as when one is applied to the forehead and the other to the superior maxilla or the suboccipital region. A record of such movements of the eyes when the left electrode was applied to the forehead above the left eye and the other to the superior maxilla below this eye is shown in figure 2. The direction of the deflection of the suspended thread of the galvanometer in movements of the eyes laterally, a type of movements to which my studies have been mainly devoted, so far, thus shows that in conjugate movements of the eyes to the right, the area in contact with the electrode on the right temple is in its relationship to the galvanometric circuit positive to the corresponding area on the left temple, and that the reverse obtains in conjugate movements of the eyes to the left.

In nystagmus, a phenomenon consisting of a series of cyclic processes, each of which is made up of a slow movement of the eyes to one side which is followed by a quick movement to the other side, the records show a corresponding series of successive cycles.

Each of these cycles is seen to be made up of a somewhat prolonged wave which passes obliquely in the direction below the abscissa and is followed by an upstroke, which in turn is followed by a short pause, in the case of nystagmus to the left (figs. 3 *B*, 3 *C*, 3 *CC*), and by a similar wave which passes in the direction above the abscissa and is followed by

a downstroke to be followed by a pause in the case of nystagmus to the right (figs. 3 *D*, 3 *E* and 3 *EE*). The prolonged phase, indicating a comparatively slow deflection of the suspended thread of the galvanometer, corresponds in direction with that of a voluntary movement in the direction of the slow component of the nystagmus; the upstroke or downstroke, on the other hand, indicating a quick return movement of the deflected thread, has a direction which corresponds with that of a voluntary movement in the direction of the quick component. One may therefore unhesitatingly assume that these phases in the record represent the slow and the quick components of nystagmus.

These phases, the slow and the quick, have generally the same range of movement, the eyes during the second phase returning only to their original position and not going beyond it. This is not invariably the case, however, and in certain pathologic conditions one notes that there is no correspondence between these two. This, in conjunction with the fact that the quick phase is under certain conditions subject to modifications of its own, becoming prolonged and undulatory in character (fig. 6 *C*), shows that this phase is not merely a passive process, a recoil of the eyes due to a relaxation or inhibition of the muscles which brought about their primary deviation, but is an active process and is brought about by a contraction of the antagonists of these muscles. This is in accordance with the fact which I brought out in a previous communication [1] that the quick component is abolished by a lesion of the motor cortex which normally activates the muscles moving the eyes in the direction opposite that of the primary deviation. The quick phase is generally separated from the succeeding slow phase by a short pause, which in certain pathologic conditions, may be persistently absent. Generally, in the normal state, the duration of the primary deviation is about from one and one-half to two times that of the return movement, the duration of the latter corresponding with that of a voluntary deviation of the eyes, which is from one-twelfth to one-tenth of a second.[2] The duration of the pause varies within wide limits. It is usually much shorter than the pause during the voluntary movements of the eyes as recorded in figure 1 (although for the purpose of this record the voluntary movements of the eyes have been executed within the shortest possible space of time). As a general rule, the duration of this pause varies inversely with the intensity of the primary deviation, i.e., the stronger the pull of the eyes from their primary position at or near the midline the shorter the pause in which the eyes remain there, so

1. Meyers, I. Leon: Nystagmus: Neuro-Otologic Studies Concerning Its Seat of Origin, Am. J. M. Sc. **166**:742 (May) 1925.

2. Waller, August D.: An Introduction to Human Physiology, London, Longmans, Green & Co., 1893, p. 336.

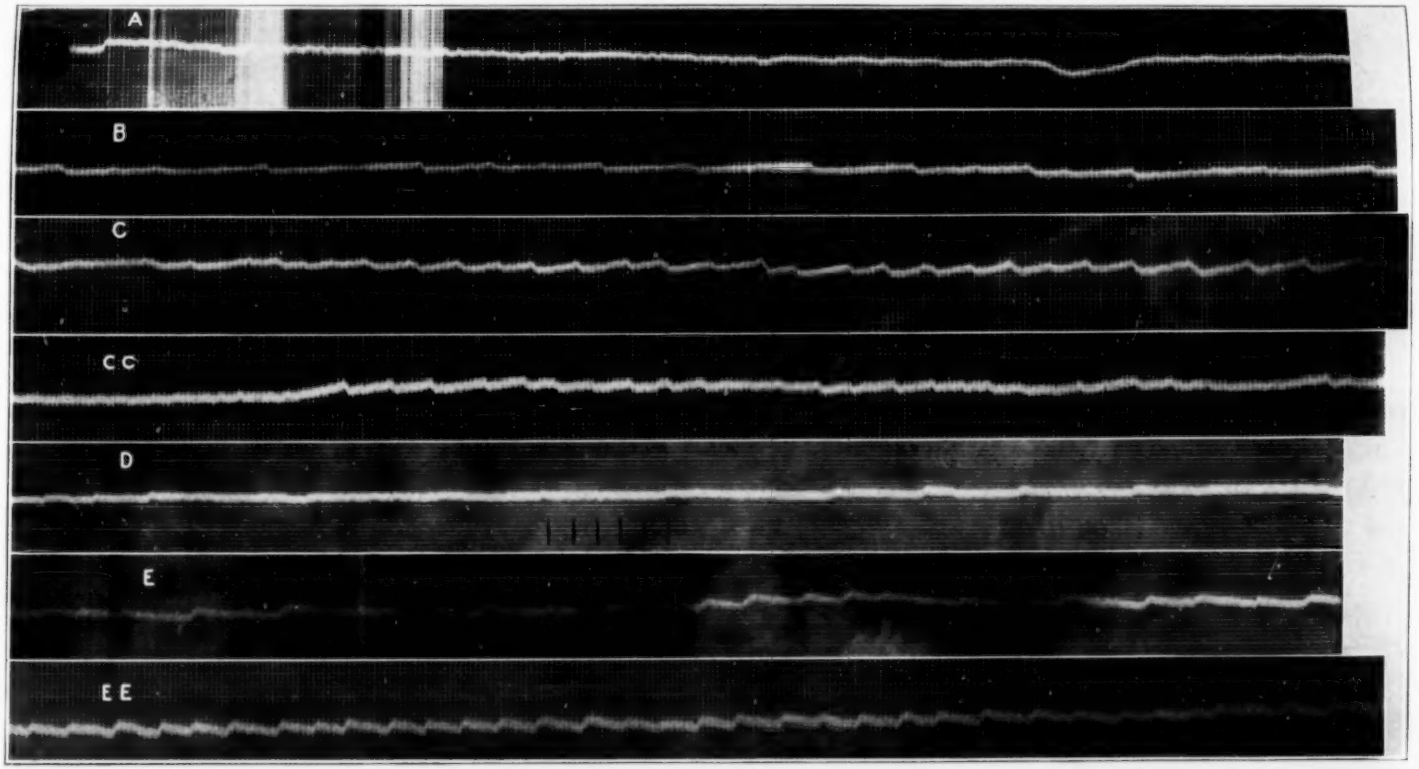

Fig. 3.—Electronystagmogram of a normal person. Caloric nystagmus. The subject was in a sitting posture. *A*, before irrigation was started; *B*, stimulating right vertical canals; *C*, stimulating right horizontal canal; *D*, stimulating left vertical canals; *E*, stimulating left horizontal canal; *CC*, stimulating right horizontal canal, subject being in the recumbent posture, and *EE*, stimulating left horizontal canal, subject being in the recumbent posture.

that in certain cases showing a markedly accentuated labyrinthine response (figs. 5 *D* and 5 *E*) there may be a total absence of this pause.

It should be noted further that the rotatory type of nystagmus which is also recorded by this galvanometric method (figs. 3 *B* and 3 *D*), shows, like the horizontal type, a primary and secondary phase as well as the pause. There is, however, a clear and unmistakable difference between the records from these two types. The primary deviation in the rotatory type is shown clearly to be lacking in force and, in correspondence with this, the pause is much prolonged.

THE ORIGIN OF THE ACTION CURRENTS IN NYSTAGMUS

As to the muscle excitation of which in conjugate movement of the eyes gives rise to the current, my studies show that during the slow phase it is the external rectus muscle on the side toward which the eyes are moving and not the internal rectus on the other side that is responsible for it. The current during this phase is found to be greatly diminished (fig. 4 *C*) when the former muscle is affected, regardless of the fact that the contralateral internal rectus muscle functions normally, and to be unaffected by a paralysis of the latter muscle (fig. 5 *E*). During the succeeding quick phase, on the other hand, the current may be led off either from the external rectus of the eye toward which the return movement takes place (figs. 5 *B* and 5 *C*) or, if this muscle is paralyzed (fig. 4 *D*), from the contralateral internal rectus. In other words, during the slow phase, the current led off through the galvanometer is the one that originates in close proximity to its positive pole, in the ocular muscle that is subjacent to it, whereas, during the second phase, the current may be led off even though it originates quite a distance away from this pole, in the internal rectus in the contralateral orbit. The reason for the greater intensity of the current during the second phase is probably to be found in the fact that the quick phase is the more vigorous of the two. It is to be noted, however, that during either of these phases the current enters the galvanometer on the side of the body toward which the contracting muscles and its nerve impulses are directed. It enters, for example, on the right side from the external rectus of the right eye or from the internal rectus of the left eye, in both of which muscles the direction is forward and to the right.

REPORT OF CASES

A study by this method of induced (caloric or optic) nystagmus in patients with ocular or intracranial lesions gave the following results:

CASE 1.—*Paralysis of right abducens. Weakness of right internal rectus due to tenotomy. Nystagmus was induced by irrigating the ears with water at 68 F. The records obtained are shown in figure 4.*

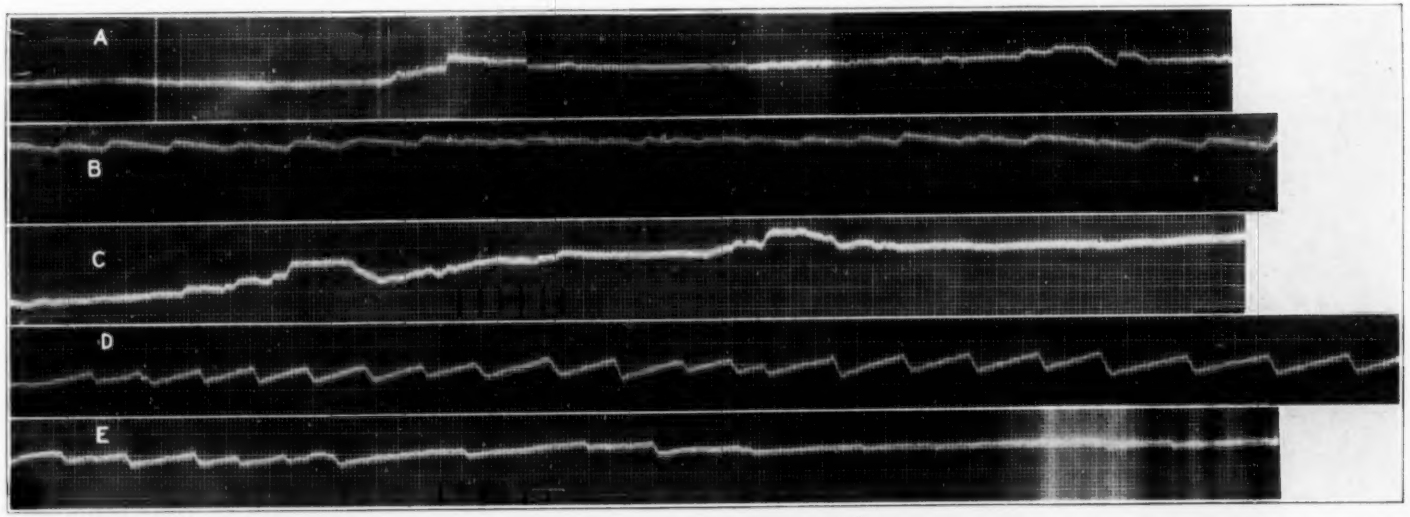

Fig. 4.—Electronystagmogram from patient with congenital internal squint on the right side. Caloric nystagmus. *A*, before irrigation; *B*, stimulating right horizontal canal; *C*, stimulating right vertical canals; *B*, stimulating left horizontal canal, and *E*, stimulating left vertical canals.

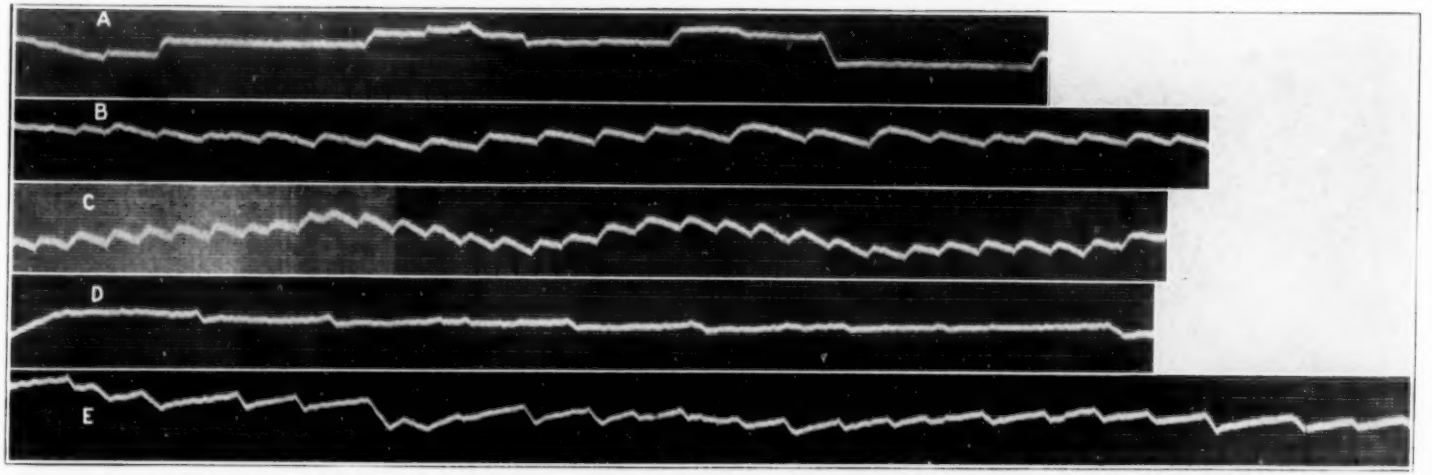

Fig. 5.—Electronystagmogram from patient with paralysis of right oculomotorius and caloric nystagmus. *A*, before irrigation; *B*, stimulating right vertical canals; *C*, stimulating right horizontal canal; *D*, stimulating left vertical canals; *E*, stimulating left horizontal canal.

Victoria B., a school girl, aged 15, had had a right internal squint since birth. The squint formed an angle of 45 degrees when the left eye was directed straight ahead. Vision in the right eye was practically lost. There was no involvement of the other cranial nerves, or of motion or sensation in any part of the body. Speech and intelligence were normal. The Wassermann reaction of the blood was negative. Dr. Theodore Lyster performed an advancement of the external rectus muscle and a tenotomy of the internal rectus muscle on the right side on Sept. 9, 1927. When this paper was written, the patient could move the right eye to the midline but could not maintain it in the latter position, the eye tending to deviate toward the inner canthus.

CASE 2.—*Complete paralysis of the oculomotor nerve on the right; hemiparesis on the left side. Cerebrospinal syphilis. Records from induced labyrinthine nystagmus by irrigating the ears with water at 68 F. are shown in figure 5.*

Jessie H., colored, aged 30, on Jan. 10, 1928, beagn to suffer from pain over the left eye. This lasted for about a week when the upper lid drooped; the eye became completely closed and has remained in this condition since. On Jan. 21, 1928, she noticed difficulty in holding objects firmly with the left hand. Within twenty-four hours, the weakness extended to the entire left side. She had not vomited, and visual disturbances and tinnitus had not been present.

Examination.—On Feb. 28, 1928, complete paralysis of the right oculomotor nerve was present. The pupil was dilated and fixed; the eye was in complete divergence and could not be moved upward or inward. The other cranial nerves were not involved. There was hemiparesis on the left side involving the face, arm and leg, with spastic reflexes on that side; no clonus was obtained; an inconstant Babinski sign was present on that side. The deep reflexes on the right side were hyperactive, but the plantar response was normal. There was slight impairment of sensation of all types on the left side. The optic disks showed clear margins, but the veins were prominent and tortuous. The blood pressure was 118 systolic; 96 diastolic.

Comment.—It will be noted that the record obtained from this patient when the right labyrinth was stimulated with water at 68 F., while she was upright with the head 30 degrees forward, yielded a nystagmus which was horizontal instead of rotatory, the normal nystagmus for this posture. This was undoubtedly due to paralysis of the superior and internal rectus as a result of which the right eye could not be moved upward and the deviation of the eye, perforce, had to occur in the horizontal plane. A true rotatory type of nystagmus was, however, obtained from stimulation of the vertical canals on the left side.

CASE 3.—*Tumor of the left hemisphere of the cerebellum—intracerebellar in location. Records of induced labyrinthine nystagmus are shown in figure 6.*

Tony P., an Italian boy, aged 13, began to have pain in the occiput and neck and over the eyes in the early part of February, 1928. Previous to this he was reported to have been well. A few days after the onset of the headache he began to vomit in a projectile manner. He also noticed blurring of vision, from which he had suffered, however, in a minor degree for several months before.

Neurologic Examination.—The patient was fairly intelligent and cooperated well. He was able to walk but tended to deviate to the right and to fall to the right on walking in a straight line. He showed a tendency to a "cerebellar attitude of the head," in this case, an inclination of the occiput toward the right shoulder. He past-pointed persistently to the right with both hands. Tremor and hypermetria (or exaggeration of all active movements) were present in both hands. The pupils were somewhat dilated and equal and reacted to light and in

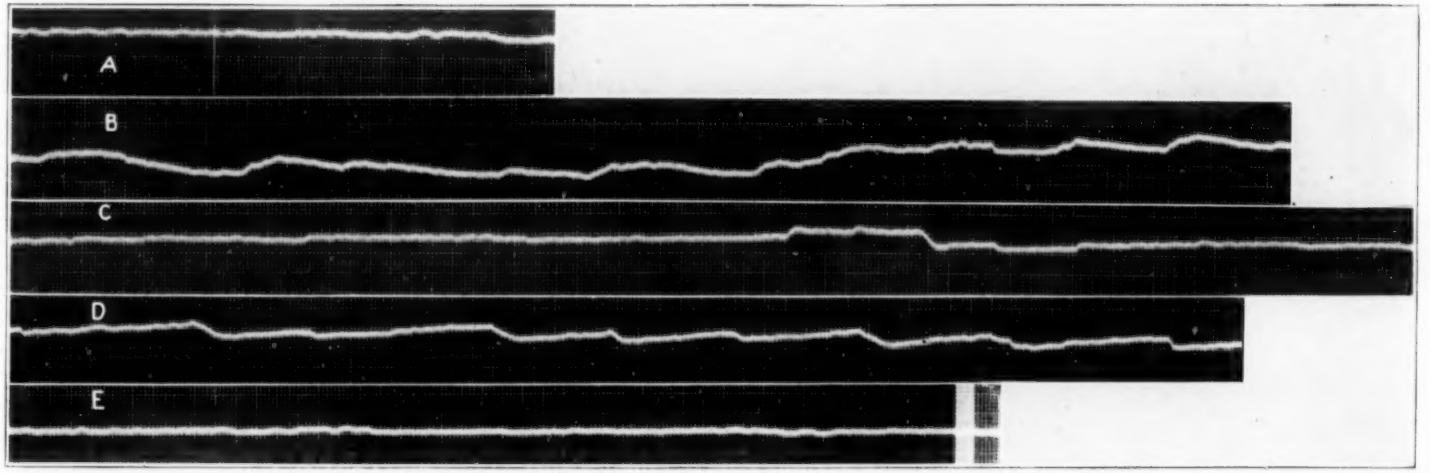

Fig. 6.—Electronystagmogram from patient with tumor of left hemisphere of the cerebellum. Caloric nystagmus. *A*, before irrigation; *B*, stimulating right horizontal canal; *C*, stimulating right vertical canals; *D*, stimulating left horizontal canal, and *E*, stimulating left vertical canals.

accommodation. Ocular movements were carried out in all directions. Slight spontaneous nystagmus was present when he looked either to the right or to the left, but was more marked when he looked in the latter direction. Vertical nystagmus was not present. The disks were markedly choked, showing an elevation of about 6 diopters. A good deal of vision was, however, preserved; there was no hemianopia. The face appeared to be somewhat weak on the left side; the palpebral fissure was wider on that side. Hearing was unimpaired, with air conduction better than bone conduction on both sides. There was no involvement of the fifth nerve, and no involvement of the palate, pharynx, larynx, or tongue. The deep reflexes were diminished on both sides, in the arms as well as the legs. A tendency to a Babinski sign was present on the right side, with a normal plantar response on the left. The superficial reflexes were present on both sides. There was no impairment of speech. Sensation was normal everywhere and there was no astereognosis. Bladder function was normal. The Wassermann reaction of the blood and of the spinal fluid was negative. The fluid was clear, under greatly increased pressure (30 mm. of mercury), and had a cell count of 3 lymphocytes per cubic millimeter; the sugar content was reduced. X-ray examination showed that the cranial vault was thin, especially in the frontal area, and had prominent convolutional markings; the pituitary fossa was normal in size and shape; the clinoid processes were intact.

Neuro-Otologic Examination (as noted on visual observation).—Douching the right ear with water at 68 F. with the patient upright and the head 30 degrees forward gave rise to a few oscillatory jerks of the eyes, but no true nystagmus, although irrigation was continued for more than three minutes; the patient pointed correctly with both hands. With the head back, a horizontal nystagmus to the left was produced which was of good amplitude; he past-pointed 2 inches to the right with the left hand and pointed correctly with the right hand. Douching the left ear with cold water, with the patient upright and the head 30 degrees forward, also did not produce nystagmus; he past-pointed then 2 inches to the right with the right hand and pointed correctly with the left hand. With the head 60 degrees back, a good nystagmus was produced which was horizontal in type; he past-pointed about 3 inches to the left with the right hand, and pointed correctly with the left. A constitutional response was not obtained on stimulating either labyrinth.

Comment.—It is seen from the history of this case that the question as to the location of the tumor, whether it was in the right or the left hemisphere of the cerebellum, was difficult of solution. The cerebellar attitude of the head, the tendency to deviate and fall to the right, the spontaneous past-pointing to the right and the pointing correctly with the right hand when horizontal nystagmus was induced from the right labyrinth suggested that the tumor was in the right hemisphere. On the other hand, the slight weakness of the face on the left side with the tendency to a Babinski sign on the right side and the pointing correctly with the left hand when horizontal nystagmus to the right was produced from the left labyrinth indicated that the tumor was in the left hemisphere (the fact was at the same time taken into consideration that, as experience has repeatedly proved, weakness of the face in tumors of the cerebellum may occur contralaterally to the lesion and the Babinski sign may be homolateral to it).

On studying the records of the induced nystagmus obtained by the string galvanometer (fig. 6), one notes a persistent tendency for the eyes to be deviated to the left regardless of whether horizontal nystagmus was produced to one side or the other. This is shown by the prolonged slow phase in the case of

nystagmus to the right (fig. 6 *E*) as well as by the tendency of this phase to be short, irregular and oscillatory in the case of nystagmus to the left (fig. 6 *C*). The quick phase in the latter type of nystagmus, on the other hand, tended to be unduly prolonged, in other words, to maintain the eyes in their deviated position to the left. The nystagmus to the left, in fact, was associated with an almost continuous deviation of the eyes to that side. This observation could best be explained, I thought, by the assumption that the tumor is situated in the left hemisphere of the cerebellum, as I have shown by experimental studies previously reported [3] that a lesion of the cerebellum on one side results in hyperactivity of the contralateral motor area of the cerebrum. A lesion of the left hemisphere of the cerebellum would consequently be associated with hyperactivity of the motor cortex on the right side, which, as in the case of a hemiplegia on the right side from a lesion of the motor cortex or internal capsule on the left, produces a conjugate deviation of the eyes to the left side. The quick component in the case of nystagmus to the left, it will also be noted, was undulatory or tetanic, a type of movement which, in accordance with the studies of Piper [4] and Wertheim-Salomonson,[5] is indicative of a cerebral origin.

Operation.—The patient was operated on by Dr. George H. Patterson, March 15, 1928. The left cerebellar lobe was felt to be firmer than the right. A lobulated mass of tumor was found in that lobe. In the anterior part of the lobe there was a greenish-gray discoloration. A ventricular needle placed in the left cerebellar lobe encountered firm resistance and entered a hard tumor. The needle in the opposite lobe entered a soft substance and gave a normal feeling. The patient showed a tendency to collapse and removal of the tumor was postponed. He left the hospital on April 4, 1928, to return for secondary operation at a later date.

Figure 7 is a record of optic nystagmus ("railroad nystagmus") in a case of a glioma of the left occipital lobe with a right homonymous hemianopia. To produce this type of nystagmus I caused a kymograph drum covered with alternate strips of black and white paper to rotate before the patient's eyes, at a distance of about 2 feet, while he was fixing his gaze on it. Normally, under these circumstances, rotation of the drum clockwise, from the right toward the left side of the patient, produces nystagmus to the right, whereas rotation of the drum in the opposite direction, or counterclockwise (for which the kymograph was held in an inverted position with the rod carrying the drum riveted to its base), produces nystagmus to the left. There is a diversity of opinion as to the effect of hemianopia on this type of nystagmus. Bárány [6] and Strauss [7] maintained that hemianopia abolishes such nystagmus toward the nonseeing half of the field, and that the loss of such nystagmus to one side may be accepted as

3. Meyers, I. Leon: Galvanometric Studies of the Cerebellar Function, J. A. M. A. **65**:1348 (Oct. 16) 1915; Cerebellar Localization: An Experimental Study by a New Method, ibid. **67**:1745 (Dec. 9) 1916; The Cerebellar Gait, J. Nerv. & Ment. Dis. **49**:14 (Jan.) 1919.

4. Piper, H.: Electrophysiologie der menschlicher Muskeln, Berlin, Julius Springer, 1912.

5. Wertheim-Salomonson, J. K. A.: Tonus and Reflexes, Brain **43**:369, 1920.

6. Bárány, R.: Zur Klinik und Theorie des Eisenbahn-Nystagmus, Arch. f. Augenh. **87**:139, 1921.

7. Strauss, H.: Die diagnostische Bedeutung des optomotorischen (Eisenbahn) Nystagmus, Ztschr. f. d. ges. Neurol. u. Psychiat. **98**:93, 1925.

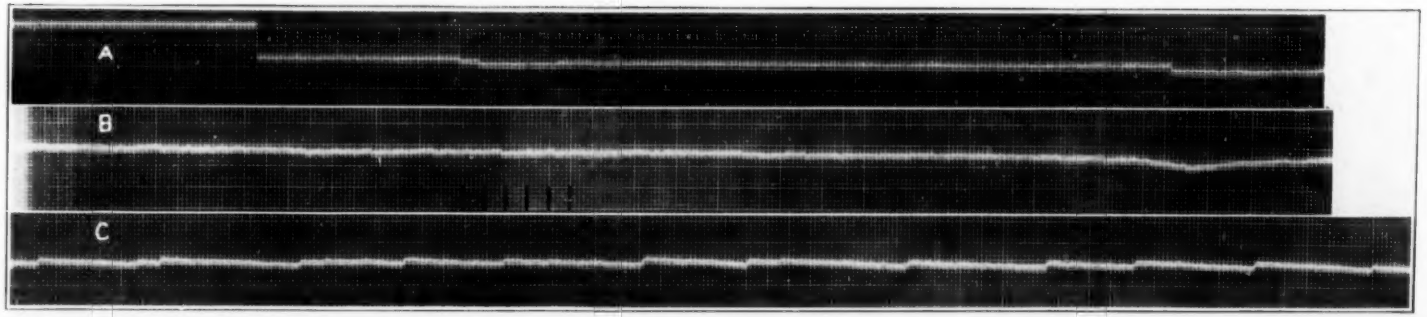

Fig. 7.—Electronystagmogram from patient with right homonymous hemianopia. Optic nystagmus. *A*, looking straight ahead before rotation of the drum (see text) was started; *B*, rotating drum clockwise, and *C*, rotating drum counterclockwise.

evidence of a loss of vision in that part of the field. Fox and Holmes,[8] on the other hand, deny this. These authors maintain that optic nystagmus is independent of the integrity of the visual field, that its loss in certain lesions of the brain is determined by an as yet unknown factor, but that it may be brought about by a break in the reflex arc of this nystagmus, which, according to them, passes through the region of the parietal and temporal lobes, and the posterior end of the second frontal convolution.

CASE 4.—*Glioma of the left occipital lobe, the major part of which had been removed by Dr. Harvey Cushing on Jan. 28, 1927. A right homonymous hemianopia, complete in the lower quadrant and incomplete (vision for larger objects being retained for a considerable distance to the right of the median line) in the upper quadrant (fig. 8).*

Clara S., a married woman, aged 34, had always been in good health until the age of 22, when she suffered from a nervous breakdown, having become unusually irritable, despondent and unable to continue work as a secretary in a district

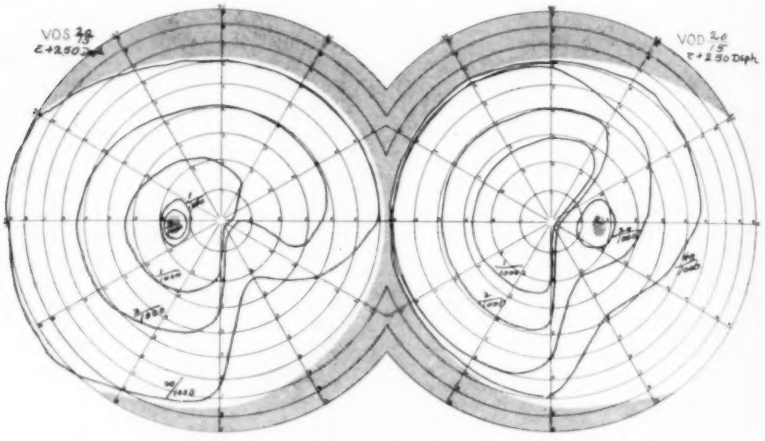

Fig. 8.—Perimetric chart of patient referred to under figure 7.

attorney's office; she attributed the breakdown to overwork. The "breakdown" was not severe, and she recovered in a few months. She had a similar, but more severe, attack in 1924, when she became much depressed, thought that everybody was against her and considered suicide. She spent a few months at a sanitarium and recovered. She felt well until December, 1925, when she had a convulsion. This occurred in the middle of the night while she was asleep. The husband reported that the convulsion was generalized, that she bit her tongue, frothed at the mouth and could not be aroused. The following morning she had an extremely severe headache and felt nauseated. She had a similar attack in which she was not completely unconscious a month later and another, mild in character, in April or May, 1926. Following each of these attacks she had headache and felt nauseated. After the attack in April or May, she did not have any more convulsions or fainting spells but had headaches, mostly in the back of the head, which occurred at irregular intervals and were at times severe. There had been no vomitting since the last attack.

8. Fox, J. F., and Holmes, Gordon: Optic Nystagmus and Its Value in the Localization of Cerebral Lesions, Brain **49**:333, 1926.

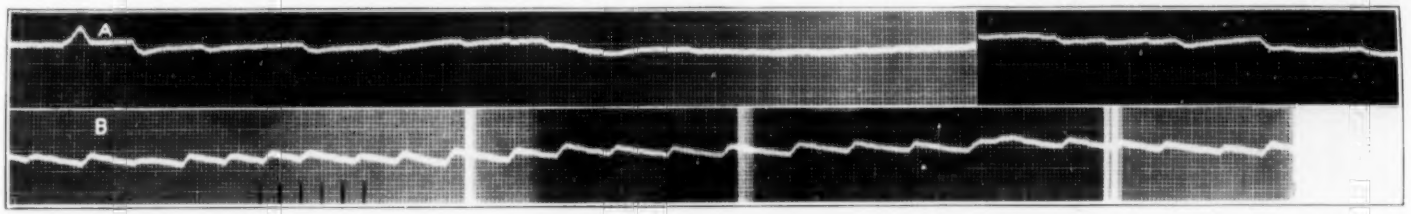

Fig. 9.—Electronystagmogram from patient with tumor in posterior fossa. Spontaneous nystagmus. *A*, looking to right and *B*, looking to left.

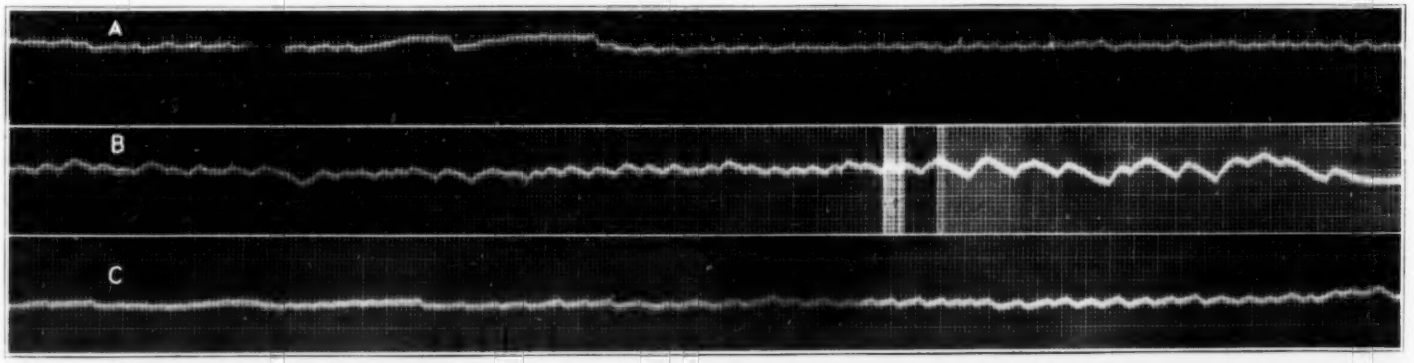

Fig. 10.—Electronystagmogram from albino. Spontaneous (visual) nystagmus. *A*, looking straight ahead; *B*, looking to left, and *C*, looking to right.

Neurologic Examination.—The patient was alert, of good mentality, and careful about appearance and dress. The pupils were of medium size, equal, and reacted to light and in accommodation. The ocular movements were normal; there was no nystagmus. The disks showed an elevation of about 4 diopters; the margins were completely obliterated, and the cups were invisible; there were no hemorrhages or exudates. Vision was preserved; the patient was able to read a newspaper with ease, but showed a right homonymous hemianopia. All the other cranial nerves were normal. Hearing was unimpaired on both sides; air conduction was better than bone conduction. There was no impairment of motion or sensation anywhere in the body. The deep reflexes were within the normal range, the right patellar, however, being a little more active than the left. There was an occasional tendency to a Babinski sign on the right. The abdominal reflexes were present on both sides; there was no Oppenheim or Gordon reflex. Tremor or ataxia was not present in either the arms or the legs. The patient was right handed and did not show any disturbance of speech of either aphasic or dysarthric character. Stereognostic sense seemed perfect on both sides. The Wassermann reaction of the blood was negative. The patient was referred to Dr. Harvey Cushing who removed the chief mass of the tumor, which was a glioma of the left occipital lobe.

Course.—On March 15, 1928, the patient was in excellent condition. Aside from the right homonymous hemianopia, the extent of which is shown in figure 8, and partial atrophy of the disks, she did not show signs or symptoms of an intracranial disease; motion, sensation, mental condition and speech were entirely normal.

Nystagmus Studies.—When optic nystagmus was studied in this case it was found that clockwise rotation of the drum, which would normally produce nystagmus to the right, did not produce nystagmus (fig. 7 *B*), whereas rotation of the drum counterclockwise produced a normal nystagmus to the left (fig. 7 *C*).

The result in this case, a case which from a clinical standpoint is very similar to case 20 of Fox and Holmes (in which at operation there was removed a large endothelioma growing out of the falx and compressing the occipital lobe) is therefore at variance with the result of these authors' optic nystagmus to either side. The result coincides with the observations of Bárány and of Strauss that hemianopia abolishes optic nystagmus toward the nonseeing half of the visual field.

Case 5.—Figure 9 is a record of spontaneous nystagmus on looking to the right and to the left in a patient with what clinical evidence shows to be a tumor in the posterior fossa. He was unwilling to undergo an operation at that time.

Case 6.—Figure 10 is a record of spontaneous nystagmus of the visual type which was obtained from a woman, aged 30, who is an albino. It will be seen that the nystagmus in this case was pendular and oscillatory, and did not present the typical slow and quick components of labyrinthine or optic nystagmus.

Clinical and Occasional Notes

UNILATERAL NEUROFIBROMATOSIS OF THE CRANIAL AND DEEP CERVICAL NERVES

Report of a Case *

GEORGE T. PACK, M.D., TUSCALOOSA, ALA.

Tumors of peripheral nerves, both sensory and motor, constitute one of the most frequent types of generalized palpable subcutaneous neoplasms. Neurofibromatosis of the cutaneous and terminal nerve filaments is eponymically known as Recklinghausen's disease. Neurofibromas of similar histologic structure are frequently found involving the subcutaneous or deeper nerve trunks. They differ from the former group chiefly in their variability in size, deep location and infrequency of pedunculation. The case reported here is unusual because of the peculiar distribution of these benign tumors and because of the significant stigmas or sequels of their occurrence.

REPORT OF A CASE

History.—D. E., a white boy, aged 11, entered the clinic complaining of an overgrowth of the left side of the face, pain and partial blindness in the left eye and daily vertigo. His parents and grandparents were living and healthy. He was next to the oldest of five children, the youngest of which was 7 months of age, the oldest 13 years. The elder brother had a congenital bilateral coloboma. The infant brother had indefinite visual disturbances. Evidence of a familial tendency toward neurofibromatosis was not found. The patient had measles at 1½ years, and pertussis at 9 years of age. His birth was spontaneous and precipitate. When 2 weeks of age, he became cyanotic and comatose for a period of six hours; he recovered, and did not suffer any recurrence or apparent subsequent harm. At the age of 2 months, a significant stationary or fixed enlargement of the pupil of the left eye was observed by the parents. At 4 months of age, the soft parts of the left side of the face became noticeably enlarged; this condition increased gradually and relatively during the ten years that followed. At 2½ years of age, at intermittent periods, he was unable to use his left leg for an hour or longer. These short periods of transient and unilateral disability occurred at irregular intervals until he was 8 years of age. At the time of the inception of this disturbance, a diagnosis of poliomyelitis was made by an attending physician. On admission to the clinic the child was in the fourth grade at school and appeared to be of average intelligence.

Physical Examination.—The patient was small, obviously underweight and underdeveloped, his height being 51½ inches (131 cm.) and his weight 58 pounds (26.3 Kg.).

Eye: There was marked exophthalmos of the left eye. The cornea of the left eye had a greater transverse and vertical diameter than the cornea of the right eye. There was a mild keratoglobus. The pupil of the left eye was dilated; it did not react to light or accomodate to distance. There was a slightly increased intra-ocular tension in the left eye. The patient retained slight ability to utilize the extrinsic muscles of the left eyeball. There was almost complete blindness

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* From the University of Alabama School of Medicine.

of the left eye, the patient retaining merely the ability to distinguish between light and dark. The vision in the right eye was normal.

Ophthalmoscopic Examination: A mydriatic drug was not necessary for the examination of the left eye. There was no intra-ocular tumor. The retina was undergoing atrophy; the blood vessels were collapsed, except near the optic disk, where they were engorged and dipped down around the border of the optic cup. The nerve head projected far into the posterior chamber of the eye. The cause of the exophthalmos was probably a retrobulbar tumor.

Face and Neck: The left side of the face appeared swollen and the cheek was pendent, yet the palpable bony framework was smaller than that of the right side. The enlargement was therefore due to the soft parts only. In the left upper eyelid, the left cheek and the left side of the neck, particularly in the posterior cervical triangle and along the anterior border of the sternocleidomastoid muscle,

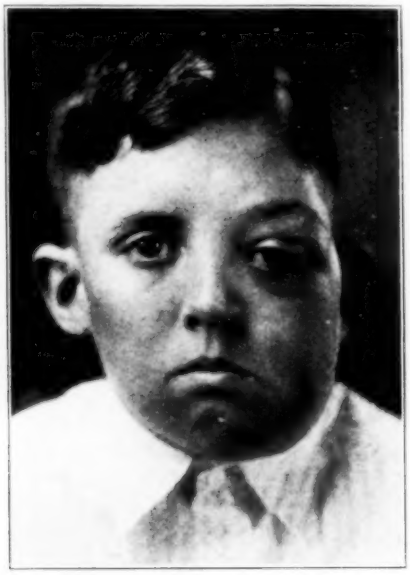

Fig. 1.—Unilateral neurofibromatosis of the cranial and deep cervical nerves.

were numerous discrete, well circumscribed, freely movable, nonpainful nodules or masses of moderate and variable dimensions. The tissues of the cheek and neck were firm but had the peculiar consistency of myxomatous tissue. A definite edema was not demonstrable in these areas. The skin of the cheek and neck overlying the mucinous subcutaneous tissue was slightly thickened, constituting the so-called "elephantiasis molle," which occasionally accompanies multiple tumors of nerve trunks, leprosy and other conditions of the peripheral nerves. There were a few scattered flat patches of brownish pigment on the left posterolateral aspect of the neck.

The teeth were crowded and incompletely erupted. The hard palate was narrow and shaped like a Gothic arch. The boy did not speak plainly.

Body: The heart was of normal size; the heart sounds were of normal quality and rhythm. The lungs were resonant and otherwise normal.

The general musculature of the patient was weak and adynamic. Obvious asymmetry existed; the left thorax, left scapula, left pectoral muscles, left leg, left arm, left hand etc., were considerably smaller than the same structures on the patient's right side. The left arm was much shorter than the right. The left hand had a weaker grip. There was a compensatory scoliosis, attributable to differences in the lengths of the lower limbs and to differences in muscle strength of the two sides of the trunk.

Roentgenogram of the Skull.—The left orbit was smaller than the right. The left antrum was abnormal in size and location. In the anterior cranial fossa and anterior to the sella turcica was a rather deep excavation. Several unerupted teeth were observed.

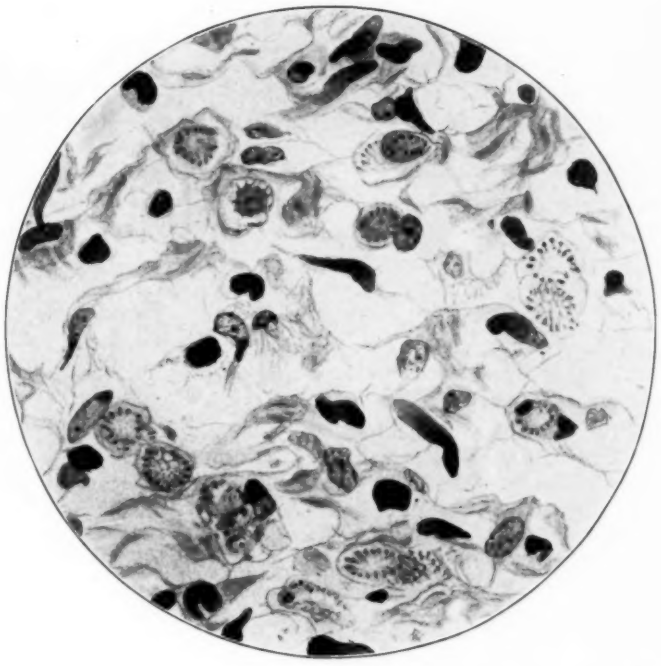

Fig. 2.—A cross section of a tumor of a peripheral nerve; × 1,000.

Gross Pathologic Anatomy.—Under local anesthesia, a nodule was excised from the left side of the neck. This was white, elastic, spindle-shaped, semitranslucent and relatively avascular. It looked edematous. It was invested with a sheath or capsule, which was prolonged at each end over the fibers of the nerve, which entered the tumor at one end and left it at the other. On transverse section, this nodosity was found to consist of three separate longitudinal, cylindric compartments separated by intervening sheaths. The many nerves of this location were segmented by multiple nodulations scattered along their trunks to give a beaded or moniliform appearance. These tumors seemed to englobe and dissociate the preexisting nerves. The translucent appearance can be attributed to mucoidal degeneration within the matrix of the tumor.

Pathologic Histology.—Although both nerve fibers and connective tissue cells were seen within the tumor, the former was not the predominant element. The nerve fibers merely passed through the neoplasm, together with occasional collagenous fibers. The local interstitial proliferation of fibroblasts (neuroglia elements?) constituted the major portion of the tumor and dissociated the nerve fibers. Most of the nerve fibers had lost their myelin elements, either because of these changes or by coincidence. It was impossible to ascertain whether or not these connective tissue cells were neuroglia cells from the sheath of Schwann, as has been asserted by many authors. In some areas, the cells were in anastomotic chains; a few multinucleated cells were observed. In the zones of mucoidal degeneration, the loose tissue contained stellate cells, similar to those occurring in myxomatous tissue.

REVIEW OF THE LITERATURE

Cheselden, in 1740, made the first intensive study of tumors of the peripheral nerve.[1] Virchow,[2] in 1863, catalogued these tumors in three groups: the true neuromas; the mixed neuromas (a mélange of nerve fibers and connective tissue) and the false neuromas, composed of connective tissue only, originating from the interstitial tissue of the nerve trunks and containing fibrous, myxomatous or sarcomatous elements. Virchow also labeled them myelinic or amyelinic neuromas, according to the presence or absence, respectively, of myelin.

Von Recklinghausen, in 1882, described the generalized tumors which bear his name today. He was of the opinion that the perineural fibers proliferate to bring about consequent atrophy of the nerve fasciculi.

Durante[3] later expressed the view that the true peripheral neuromas are tumors originating from the peripheral neuroblasts, which explains their segmental distribution along the nerves.

Verocay[4] observed the structural analogy of these tumors with certain gliomas and believed that they result from proliferation of the neurilemma or sheath of Schwann. He considered them the most frequent of the tumors of the peripheral nerves. They have been variously designated as "peripheral gliomas" or "Schwannomas." Verocay probably studied a series of tumors closely related to the true neuromas.[5]

Herxheimer and Roth[6] formulated the hypothesis that some specific element of the peripheral nerve tissue was deficient; this defect was assumed to result in a dystrophy caused by replacement fibrosis, resulting in a generalized systemic disease, characterized by multiple nodosities on the peripheral nerves and commonly termed "multiple neurofibromatosis."

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1. Masson, P.: Tumeurs: Diagnosis histologiques, Paris, A. Maloine et Fils, 1923, p. 575.

2. Penfield, W.: Surg. Gynec. Obst. **45**:178, 1927.

3. Durante, G.: Histologie pathologique des nerfs in Cornil, V., and Ranvier, L.: Manuel d'histologie pathologique, Paris, Félix Alcan, ed. 3, 1907, p. 503.

4. Verocay: Beitr. z. path. Anat. u. z. allg. Path. **48**:1, 1910.

5. Ewing, J.: Neoplastic Diseases, ed. 3, Philadelphia, W. B. Saunders Company, 1928, p. 164.

6. Herxheimer and Roth: Beitr. z. path. Anat. u. z. allg. Path. **58**:319, 1914.

COMMENT

The bone changes observed in this patient may be caused by or may be coincidental with the neurofibromatosis. This is particularly indicated in the disparity in size of the right and the left sides of the skull. Bone changes occasionally do accompany this disease. Brooks and Lehman[7] reported nine cases of neurofibromatosis in which there were associated changes in the bones, including scoliosis and abnormalities in the growth of individual bones.

SUMMARY

A case of congenital unilateral neurofibromatosis of the cranial and deep cervical nerves is reported. The multiple neoplasms are probably responsible for the skeletal deformities of the patient, particularly that of the skull.

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7. Brooks and Lehman, cited by Ewing, footnote 5.

SPECIAL ARTICLE

IMPOTENCE IN THE MALE

A REVIEW OF THE BOOK BY WILHELM STEKEL*

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The problem of male impotence has long been one of peculiar difficulty to the neurologist and urologist. While a physical basis was occasionally encountered as an etiologic factor (scrotal hernia, hydrocele, neurosyphilis, diabetes, degenerative changes following some infections—parotitis, gonorrhea, and the like), by far the larger number of cases observed belonged to the type for which a physical basis could not be found. Even the older authorities, such as Hammond and Taylor, spoke of certain types of impotence as being psychic and, more recently, Huhner has spoken of impotence due to inhibitory psychic influences interfering with the actions of the centers.

The treatment heretofore offered was as little effective as the causes were obscure. Of recent years, psychiatry has learned much of the problem of male impotence, mainly through the psychoanalytic approach. Increasingly, clinical evidence supports the view that the operation of psychic factors may sometimes be productive of results which appear to be purely physical in nature; accordingly, these conditions can be successfully treated by psychotherapy. To the understanding and solution of these and related problems, Stekel brings to bear his remarkable clinical experience, and in the two large volumes just issued takes up specifically the problem of male impotence. No less than 120 cases are cited, many of them being given in considerable detail, all illustrating the great variety of mechanisms that may be found in psychic impotence.

IMPOTENCE, A SOCIAL DISEASE

Psychic impotence is not in itself a neurosis, but is a symptom-complex which may enter as a component into any neurosis. Stekel believes that impotence reflects many of the ills to which modern society is heir. The love life of the modern man, he said, is much richer and more complex than that of savages; with the numberless proscriptions

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* Stekel, Wilhelm: Impotence in the Male. Authorized English version by Oswald Boltz, M.D., Clinical Psychiatrist, Manhattan State Hospital, Wards Island, N. Y., New York, Boni and Liveright, 1927, vol. 1, pp. 320, and vol. 2, pp. 344.

and inhibitions that modern society imposes, erotic tragedies are on the increase. Half of all mankind now suffers from a conflict between sexual want and opportunities for its satisfaction. Love life may be said to be complete when physical and spiritual love are united. All too frequently, however, one encounters instances in which, in spite of longing for spiritual love, man's physical inadequacy to love becomes apparent in the form of impotence; tenderness and sensuousness are not united. Whatever reaction a person may show to such a situation, the impotent man, at best, regards his impotence with humiliation, a target for much jest; this differs from the reaction in a woman, who can disguise her frigidity or even elevate it to the level of a virtue. Viewed in a large perspective, impotence is a disease which allows itself to be understood by and through the nature of the generation.

Contrary to the generally accepted notion prevailing among the majority of physicians who look for a physicochemical explanation of all disorders, it can be shown, on the basis of an overwhelming amount of clinical material, that practically all cases of impotence can be traced to the operation of psychic inhibitions, for which reason they respond well to rational psychotherapy. So sensitively is the modern man organized that a hardly perceptible inhibition will disturb and frustrate the delicate mechanism of erection and the pleasure associated with it.

THE CONCEPT OF IMPOTENCE

Before taking up the consideration of impotence proper, Stekel discusses the psychic factors that are normally operative in the act of coitus. The requisites of normal potency are: (1) libido; (2) erection; (3) coitus proper; (4) voluptas—pleasure during coitus and preceding orgasm (pre-pleasure); (5) ejaculation, and (6) orgasm. These requisites stand in a definite relation to one another in quality and time; any disturbance in such a relationship brings about impotence.

It is hardly possible to set up a rule regarding how often or how little a man should copulate; it varies with different men, and with each man at different periods. The acme of sexual potency depends primarily on the quality of the sexual object placed at its disposal.

As ordinarily conceived, impotence means a functional inadequacy of the genital apparatus, the psychic cause being expressed by and correlated with somatic functional inadequacy during the act. However, the cause in question may go farther back and exert its inhibitory influence in the preparation for the sexual act. A great variety of forms and degrees is encountered here in which the various stages and execution form a chain, one end of which is represented by impotence during the act itself. Starting with the most evident symptoms one may now follow the chain

back, and it seems almost arbitrary to decide where potency ends and impotence begins.

One must speak of impotence when the man is unable to accomplish the act in its entirety, even when there is an extreme desire for the act; one must also include here cases of men, who although fulfilling the act adequately, perform it without libido, that is, are anesthetic. A series of psychic causes are interposed between libido and its realization and secretly tend to frustrate the sexual act, this even if the frustration is an incidental effect of a tendency actively directed elsewhere. The secret psychic causes sidetrack the libido and are thus responsible for substitute formations which in reality are often concealed indications of the nature of the inhibitory tendencies.

The inhibitory and aversial influences may begin and end in the preparation for the act, as when there is a conflict with another sexual drive (fetichism, homosexuality) which blocks the normal wishes: during preparation for a normal advance (a restraining phobia); then at a stage of closer contact (forgetting a rendezvous); then on being together; then with the preliminaries for coitus (sudden indisposition, anxious bashfulness about nudity); then in the form of an insufficient or absent erection when libido is present, is vanishing or has changed its direction; then directly before the eleventh hour, as ejaculatio ante portas or as ejaculatio praecox after successful penetration, and finally, as if to undo all preparations, as an absence of orgasm.

The majority of patients whom one observes are those with relative impotence, persons who show waves and fluctuations of potency on different occasions and with different women. In the extreme, more rare form, that of paralytic impotence, the power of erection appears to have been entirely abrogated or is confined to a small degree of function. In rare cases, speedy erection occurs and forthwith disappears; in most cases there is only a slight enlargement of the organ; in intermediate cases there occurs a semierection which makes the introduction of the organ impossible. When the power of erection has entirely gone, morning erections are also absent. The seminal emission follows with more or less strong orgasm, though this at times may also be entirely absent, the organ remaining flaccid. With the organ flaccid, the man may ejaculate on kissing or embracing, or even when conversing with or seeing a sexual object. Pollutions proceed in the same manner, as the result of embracing a sexual object in a dream. This form of impotence may occur in homosexualists, fetichists and in some persons even on reading sadomasochistic literature. All these cases are only a variety of ejaculatio praecox and like the latter are conditioned by psychic inhibitions. In them one observes, as an expression of oncoming recovery, that the patient will have erections without coming to an ejaculation.

THE ETIOLOGIC FACTORS OF IMPOTENCE

There is hardly another physiologic process which can be so easily disturbed by inhibitory psychic factors as the act of erection, and it is seldom that the inhibitory idea is conscious; conscious ideas are not so serious and also seldom lead to complete impotence. With normally developed genitalia and normal sex glands there is no innate, organically conditioned impotence, but only a psychic one, the functional nature of which is evidenced by the fact that a man impotent with one woman can unfold his entire sexual powers with another woman. If the second erection is better than the first, then the impotence is only psychic (because of the overcoming of inhibitions). A person who is impotent because of weakness is paralyzed after the first attempt, and the second attempt, if it occurs at all, is less successful than the first.

Before taking up the question of the etiologic factors involved in impotence, Stekel first disposes vigorously of certain fallacies which he believes are still widely prevalent among members of the medical profession. There is a notion current among many that the greater the excess the sooner will the natural power be lost, and that early loss of power in civilized man is essentially due to his excesses. Accordingly, all kinds of advice are given. This fairy tale about the need for gentle treatment of the procreative force and the blessings of moderation is nothing but a myth. As a matter of fact, quite frequently, perhaps universally, the very persons who give scant consideration to the preservation of their potency maintain it to advanced age, whereas those who are economical about it frequently lose their full sexual power prematurely. A frequent observation is that persons endure so-called "sexual excess" much better than abstinence; while the "sexual" constitution certainly plays a rôle, the psychic factor is of greater importance than the constitutional. Above all, the most important factor is the power of inhibitions surrounding the sexual impulse. No one whose sexual act is accompanied by fear and inhibition can unfold his entire sexual power. Neither abstinence nor excess results in "physiological impotence." When the particular requisites for potency are fulfilled, potency returns.

Potency does not depend on age; capacity for orgasm is maintained physiologically until death and may not be an exception in old age. Regular and frequent intercourse does not undermine one's vital strength. Celibates, as a rule, do not attain old age. Abstinence is directly harmful and shortens life. Love and regular sexual intercourse keep people hale and hearty and work for longevity. A certain wealth of generative forces is advantageous for longevity; the vitality to create others stands in closest relationship with the vitality to restore one's self. Only that man becomes impotent who gives up his potency.

There are men who, after a period of impotence lasting even ten years, become potent in advanced age. Again, one finds that many cases of impotence in advanced age are only psychic and may be traced to mental inhibitions. Reappearance of potency after a period of impotence in old men is not due to hypertrophy of the prostate or to other organic changes.

What has been said of sexual excess and abstinence as etiologic factors in impotence holds true also of masturbation. Popular and scientific books maintain the false notion that masturbation causes premature impotence; the physician, instead of being a healer, becomes a moralist and a preacher. There are many victims of such literature on masturbation.

If it were true that masturbation is responsible for impotence, why should the ill effects of masturbation make their appearance after many years of health? There are many instances in which auto-erotic practices did not leave harmful results until the person, from one source or another, gained the idea that the practice would be followed by horrible consequences, of which impotence is one. Should such an individual by chance experience a "fiasco" (extramarital relation) the fact will be attributed to masturbation as the main cause and not to some other factor. The ill advice of a poorly informed physician often works havoc with a patient. Masturbation is the "blame reservoir" for all manner of self-reproach.

Contrary to the prevailing notion, masturbation in itself is harmless and does not have an effect on or relation to potency; the same is true of pollution. To appreciate it adequately, one must realize the force behind the practice of masturbation. When a paraphilic person masturbates, a seemingly complete impotence may appear after masturbation, not as a result of but as an expression of inhibitory processes against sadistic, necrophilic or other paraphilic fantasies accompanying the sexual act. The coincidence of the phenomena need not be interpreted in terms of cause and effect; they both may be the effect of another cause. There are men who have masturbated excessively for fifty years and are still potent. On the other hand, there are instances of recent impotence in persons who have never masturbated. It is known further that children of chronic masturbators are often in remarkably good health. Their masturbation was only a substitutive act and was not done against inner resistance.

The clinging to an infantile impression is frequently found in masturbation or impotent men. The power of erection and the traumatic image remain permanently associated; one becomes conditioned on the other. Many persons masturbate with a particular picture or fantasy in mind; and it is this accompanying fantasy that furnishes the driving force behind the indulgence in the practice.

Pollutions likewise do not reduce sexual powers. Pollutions are signs of a violent, ungratified sexuality; they are, in fact, always masturbatory acts, occurring, however, in the absence of consciousness.

While it is true that many onanists are impotent, this is because they are paraphiliacs, persons whose sexual aim is not a woman or who seek some form of gratification which is subject to veto—sadists, masochists, urolagnists, homosexualists or passion-murderers. To these persons, masturbation represents the only adequate form of sexual gratification because there is always a "specific pleasure-arousing fantasy" associated with it. When masturbation serves as a substitute for the normal act, it may easily be given up and is not associated with much pleasure. Other persons receive greater pleasure from masturbation than from the ordinary sexual act because masturbation protects them from paraphilias.

What is ordinarily written about the danger of various dissipations, excessive masturbation and coitus interruptus proves on more honest analysis to be false. Immoderate masturbation practiced to advanced age, impotence and excesses are in themselves symptoms of, and self protective measures against asocial and atavistic impulses. Masturbation thus fulfils an important social function; its suppression would increase the number of sexual crimes.

The impotent person excludes himself from reproduction as long as he considers himself unworthy and incapable of it. Sadism has always been an enemy of civilization, and sadists who are afraid of themselves must paralyze the sexual impulse. One can thus appreciate the terrible punishment which conscience places on a pleasure the justification of which has been forfeited. The union of hatred with absolute potency creates the sadist, the passion murderer, the sexual criminal. The amalgamation of hatred and impotence is an expression of a curative tendency and under proper guidance can be cured. Genuine love can redeem these patients.

It is a frequent, one might say an almost universal, observation that these ostensibly impotent men still have more or less strong erections in the morning during a dream or on awakening. Mistakenly, these erections are considered to be due to an accumulation of urine in the bladder and are attributed to the reflex action of a distended bladder. There is no greater physiologic absurdity than these so-called "bladder erections." If it were possible to produce an erection by distending the bladder, then merely a retention of urine would be sufficient and one would have a simple means of curing impotence; one would need only to advise a man to wait until his bladder is distended and to use the ensuing physiologic erection.

Urologists—in spite of stimulation of the "caput galliginis"—are unable to obtain an erection in impotent men, and priapism never arises

from distention of the bladder. Again, prostatic troubles, which often cause astonishing amounts of residual urine, ought likewise to command an amazing potency; this in no way corresponds with facts. The experienced physician, therefore, will warn against utilization of the morning erection.

The morning erection or that occurring during the last hours of sleep, on which it depends, has quite a different origin, which is psychic. The psychically impotent person is subject to many inhibitions concerning his sexual life. During sleep the dream attempts to circumvent these inhibitions by erecting dream situations that permit the realization of the hidden sexual craving; whereupon erection is stimulated, only to disappear soon on awakening. A pollution may also result from the dream. As a matter of fact, a morning erection is the most reliable indication that impotence is psychic and insures a favorable prognosis with psychotherapy.

The presence of morning erections or erections occurring at night, the irregularity with which erection may appear at times, its presence on masturbation and its failure with a woman, are clear indications of its functional character. On the other hand, the absence of morning erections and of erections in general does not imply necessarily that one is not dealing with an instance of psychic impotence; it may be manifested by many symptomatic acts.

After these preliminary considerations, attention may be turned more specifically to the nature of the inhibitory psychic factors that stand in the way of realizing full potency. Unconscious loves and hatreds are prolific sources of impotence. A person who, whether for social or economic reasons or as a result of pressure from the family, marries, not the girl he loves, but another, may find himself impotent in marriage because his feelings are elsewhere. Another instance is when a man is obliged as a duty to marry a clandestine lover and reacts with impotence. An unconscious or even a fairly conscious hatred of the wife, a love of the wife but a hatred of her family, a resistance against the over critical attitude of the wife, and unrecognized jealousy may also result in impotence. However accidental the first expression of impotence may be, its cause is placed elsewhere—past excesses, masturbation, and the like. Through a sense of guilt, arising from various sources, this impotence comes to be acknowledged as a weakness brought about by sins of the past.

More than that, in every case of impotence one must seek a secret love requisite on which adequate potency seems to be conditioned; the patients, however, either hide or are unaware of their fantasies. These prerequisites may be peculiar, absurd or bizarre: a particular dress, a particular setting, or a particular reaction may be specifically required of the partner; stimulations of various parts of the body, from touching

to flagellation and physical injury (real or pretended); various paraphilias—fetichism, pluralism, voyerism. Most of these are conditioned on infantile experiences that have become fixed. Erotic symbolism often lurks behind loss of sexual power; it signifies that sexuality has become fixed and womanhood is renounced.

EJACULATIO PRAECOX

Stekel also takes up the more specific problems associated with psychic impotence. According to current, generally mistaken, conceptions, ejaculatio praecox is due to an innate weakness of sexual constitution, severe neurasthenia, sexual excesses, masturbation or pollutions. Clinical material, however, fails to support this view. Ejaculatio praecox is never anything more than a symptom, for in the same person periods are observed in which ejaculatio praecox gives place to normal potency. If one looks on the sexual act as the resultant of two groups of opposing forces, namely, the sexual impulse proper on the one hand, and the social and moral inhibitions on the other, one will observe that ejaculatio praecox is a compromise between these two tendencies. With a strong inhibition, the libido can assert itself only with difficulty; the libido becomes reduced by the rapid orgasm because the power of the inhibition forces a rapid settlement of the conflict. Ejaculatio praecox and related disorders are present whenever something is wrong with the love relations. All the delicate mechanisms of love, regression to the infantile, secret revenge, unconscious jealousy, injured feelings and the struggle of the sexes can under certain circumstances release ejaculatio praecox, and from fear of it cause it to become permanently fixed.

The following situations are observed: 1. The libido is weak because of absence of adequate gratification—scant stimulating value of the sexual object—fatigue, weakness, disease, antecedent sexual gratification. Usually, the second coitus lasts longer than the first. 2. Great excitation occurs in consequence of extravagant expectation—rapid orgasm and ejaculation. 3. The man experiences forepleasure in fantasy and an inability to wait; the second coitus will show much longer duration. At times, however, it is impossible to secure an orgasm with a second coitus; in severe cases ejaculatio praecox occurs just as rapidly with the second coitus as with the first one, often more rapidly. Instances are known of a first coitus with fair potency and a second with ejaculatio praecox. 4. As a result of inhibitions, there occur fear of infection (actual presence of an infection may be followed by diminished potency), religious and ethical considerations—a protective function of conscience to prevent an immoral act (teacher cohabiting with pupil; extramarital relations, and the like), as if the inner voice were to say, "End it;" "Do

absolutely nothing." It is particularly in this group that one finds persons in whom ejaculatio praecox and ejaculatio retardata alternate.

The conditions producing ejaculatio praecox are the same that are responsible for impotence in general. One often encounters persons who may find themselves suffering from ejaculatio praecox in an attempt with a fiancée. An instance is recorded in which the mechanism was that the man really wanted to get married but the fear of losing respect for the girl or losing the girl once she had been possessed, produced impotence. Similar mechanisms may even appear on the wedding night as an expression of the wish of the man not to give up his freedom.

Sometimes there are two conflicting motives. An inner urge drives a man to marry one girl; economic greed drives him to seek a wealthy companion. If the latter feeling is victorious, the marriage may be accompanied by impotence. Some men are never in love; they nip in the bud every possibility of it because of emotional dependence on parents and the strict moral censorship they have imposed. An unloved person is a protection to them; a loved person is a danger. Impotence or ejaculatio praecox, then, is a protective measure for such a man, because he is afraid of love and woman. Whenever the protective measure ceases to function and gives way to the power of his sexual instincts, the intellect steps in and makes a rapid end of it.

In some instances ejaculatio praecox is a reaction to being humiliated by a wife who tries to act the rôle of the superior in the family. Sometimes ejaculatio praecox is a reaction to a wife who loves another man; however carefully she may hide it from her husband, her actual feeling is expressed by indifference, aversion and the like.

Fixations on the family are also frequently found in the anamneses of patients with ejaculatio praecox. One sees the sons of highly moral parents again and again trying to free themselves from the parental imperatives and to play the rôle of "men of pleasure." The attempt usually fails miserably, and the erotic relationship, in consequence of deficient potency, never blossoms to the full.

Patients with ejaculatio praecox are sometimes treated by electricity, but without benefit. Mechanical treatment is often dangerous. Treatment by massage of the prostate or local injections of masculin, serves only to arouse and increase the latent homosexual component of which the patient is not conscious.

DISORDERS OF THE ORGASM

Orgasm is an exceedingly sensitive reaction; a change in it may sometimes be the first manifestation of a disorder in the love life. The strength of an orgasm may vary from a feeling of tickling, associated with a pleasurable sensation, to such profound experiences that the indi-

vidual groans with sexual pleasure, becomes confused and even loses consciousness; epileptic attacks have occurred following orgasm. The orgasm varies with age, with the nature of the sexual object, with the mood and frame of mind and with the fulfilment or lack of fulfilment of specific love requisites. Such disorder may show itself in gradations that run somewhat as follows:

1. The orgasm is pleasurable, but is either accompanied or followed—perhaps the day after—by different degrees of unpleasant sensations, pain, paraesthesias, fatigue, disgust and anxiety, which may sometimes be so pronounced as to make the patient renounce coitus because he is afraid of the pains. The pains are diversely localized, now in the occiput, now in the legs, but mostly, however, in the spinal cord (as if the entire cord has run off). Similar pains in consequence of autosuggestion are observed after masturbation, which is mistakenly interpreted by the physician as an objective proof of the injurious power of masturbation. With a disturbance in sex relations already present, the physician confirms to the already anxious patient the injuriousness of coitus and recommends further limitations of sexual pleasure. Often, coitus aggravates symptoms that were already present. A neuralgia may become worse after each coitus; gallbladder pains may recur regularly, and myalgia may directly increase beyond endurance after coitus. An intractable vertigo, sometimes diagnosed as due to arteriosclerosis, often has the same origin. Instead of pains in the legs there may be weakness in the legs (hysterical paresis).

The pains which sexual hypochondriac persons experience after coitus are described as unbearable and unusually excruciating. Sexual excesses, coitus interruptus, various paraphilias and coitus in an uncomfortable position are readily alleged as causes of the lancinating pains, which is not true. Often it is assurance against an impulse to obtain tabooed pleasure. The pains may be due both to abstinence and to moral inhibition. The "inner negation" expresses itself in pains which enforce virtue.

2. All feeling of pleasure is absent, but in its place is a more or less intense pain which is usually localized in the glans, though it may also radiate to the perineum and display the character of testicular pain. An instance is recorded of a person whose coitus with his wife was accompanied by intense pain which arose because, during intercourse, he indulged in incestuous fantasies about his daughter and the reality itself amounted to a pain.

3. The ejaculation is strong, but the orgasm is markedly reduced, as is the power of erection, which, in comparison with the former, acts with less rapidity and obeys the libido less promptly; copulation, it is claimed, is agonizingly tasteless and is followed by ill humor.

4. The ejaculation occurs without orgasm; the semen flows off without the characteristic feeling of pleasure. The anticipation of pleasure is followed by disappointment (not to be confused with cases in which men deliberately postpone orgasm).

5. After long coitus (often an hour) a weak orgasm is forced (ejaculatio retardata).

6. Orgasm occurs without ejaculation (rare).

7. Despite hours of effort, tormenting anticipation and the feeling that the orgasm is due within a couple of frictions, it does not come; bathed in perspiration and exhausted, the patient gives up all effort.

Among women, such men are regarded as sexual athletes, because they seem to experience a number of orgasms, although to the man in question the condition is one of misery. Sometimes they may force an ejaculation that is associated with a weak orgasm or one in which the orgasm is entirely lacking and with the substitution for it of an unpleasant feeling or even an intense pain. It is characteristic that these men consider themselves impotent; they have no confidence in their potency, erection does not occur and coitus is impossible. In others, after several movements ejaculatio praecox sets in and may also take place without any orgasm. Indeed, fluctuation between ejaculatio praecox and ejaculatio retardata et sine voluptate is really the rule; these men are now impotent, now semipotent, now apparently very potent.

Among impotent men one not infrequently finds persons who have a semierection, sometimes quite constantly, from which, because of accompanying fantasies, they draw so much pleasure that the orgasm of the end pleasure becomes superfluous.

In one case the patient was emotionally dependent on his mother, who exacted a vow from him that he would never have sex relations until after marriage. He broke the vow, and this became an etiologic factor in his psychic impotence. Sometimes it is an oath sworn on the life of a dear relative or in a church, or a promise given to some one on a deathbed, or even a false oath. Such a promise as: "As long as you are faithful to your wife, your children will not die," if broken, will result in a man consciously upholding his virtue by withdrawing the pleasure premium of sexuality, an orgasm.

All these reactions are only protective measures against the domination of sexuality, mostly unknown to the person himself, which, for one reason or another, he cannot realize in his partner. Thus, a man who has very cruel sexual instincts (beating, strangling or stabbing the sexual partner) may be able to maintain normal coitus of long duration without being able to attain an orgasm. When the specific sexual situation desired can be produced in an unglossed or even in a mild form, the orgasm will appear rapidly. This will explain why a man can be

impotent with one woman and potent with another. Persons who suffer from ejaculations without orgasm and react to a discussion of homosexuality with disgust, aversion or vomiting, are themselves only disguised homosexuals.

Some men are impotent because they fear that with the experiencing of pleasure they might become enslaved to womanhood and thus be forced to be submissive; it is often an expression of the struggle between the sexes. Even when such a man maintains loudly that he loves the woman, his impotence speaks to the contrary. All neurotic patients suffer from excessive hatred which they desire to convert into love; hence, their eternal longing for love which verifies their inability to love. Under the influence of psychic tension love with them can be converted into hatred, and this love deficiency is betrayed by impotence or dyspareunia as the case may be.

In a case of absence of orgasm, as recovery takes place there will be first an ejaculation without orgasm; soon afterward the orgasm comes timidly, gradually growing until it attains its former strength.

IMPOTENCE AND MARRIAGE

That the marriage situation affects potency is a daily observation and is further attested by clinical experience. Occasionally, one observes that on marriage a young man goes on a regular orgy and finds himself in possession of sexual powers which he had never suspected and which he is not likely to equal or even approach in any future situation. A number of factors enter here, of which the overestimation of the love object, long courtship and the sanctioning of sex relations such as marriage gives unfold potency to its maximum. All cases of rupture of the vagina and rectum occur after extramarital or very violent intercourse. There is hardly a marriage in which the husband has not at some time experienced a period of temporary impotence. In many cases, on the wedding night men are seldom heroes; impotence and ejaculatio praecox are present in more than half of the cases, for which rationalizations are not lacking (sparing the wife, etc.). Soon, however, there is better adjustment, but as the attractive values of the wives become reduced, there is also an apparent lessening of libido and reduction in potency; in extramarital relations these men show increased potency. Many men fear marriage and defloration because of repressed sadistic motives; others see in the bride an image of the mother or sister and fear to face the situation. One then may have impotence with the consummation of marriage.

Potency may be conditioned on passivity—the patient wants to be taken; marked masculine aggressiveness may also make the same patient potent. This requisite for potency may be an expression of memory vestiges of intentional and unintentional manipulations during childhood.

Some men are afraid of marriage because they are uncertain whether the wife will fulfil this demand. Moreover, some women display great resistance to it. Failure to meet this demand often drives married men into extramarital relations.

Some prospective bridegrooms, fearing impotence in marriage, run to a prostitute, find themselves impotent and do not venture to get married. Here a great admiration for the fiancée, inner moral inhibitions, fear of infection and struggle for freedom, all unite to produce impotence. In other cases it is moral inhibitions, implicit homosexuality, fixation on the family, a feeling of guilt and fear of punishment which unite to produce a symptom-like impotence.

Impotence may arise in the course of the struggle between the sexes as a result of humiliation, as a protection against sadistic tendencies, and potency may return with victory over the partner. Cases of impotence arising in marriage, especially during the first weeks, can be cured if treated at the onset. The attitude and behavior of the wife usually decides whether the impotence will become permanently established. With marital difficulties, the sadistic component of the sexual impulse emerges into hatred and with this potency as a rule vanishes.

There are men who in spite of entertaining free views on sexual matters are inwardly pious. They are unable to establish clandestine relations while married, for the sanctity of marriage to them is more than an empty concept. Chaste men at heart, they may transform their conscious piety into mysticism; they may even become ascetic and renounce womanhood entirely; this, however, may have an additional basis—they are afraid of women.

Sometimes potency returns after the death of the wife, the father, the mother, or others. A man had a tendency toward passion-murder, to strangle his wife during coitus; he dared not be potent—impotence was merely a protection. All his frustrated attacks of violence were rudimentary passion-murders—a bit of reality and a large piece of fantasy. There may be potency in the absence of the wife, impotence in her presence. Behind many cases of impotence lurks a fear of marriage. Many sadists seek refuge in religion as a protection against their impulses.

Impotent men should not be warned against marriage. Many impotent men become potent only in marriage; they are moralists with an innate hidden morality, which considers extramarital coitus a sin, which is practiced only under severe inner resistance. Some of the best husbands are to be found among men who have been impotent; such husbands are grateful to their wives. Marriage, as already stated, can also produce impotence. Among impotent men who are single one will find some who are apparently free from all inhibitions and who have sought gratification from prostitutes in vain; they have found themselves either impotent or

semipotent; they have had liaisons with girls and have failed completely. Such men have a secret inner religion and struggle unsuccessfully against inner inhibitions. In all such cases one will never attain any results by recommending extramarital coitus, nor, as elsewhere, are drugs or other methods of any use. Often, these are men who were formerly potent but in whom a religious transformation has appeared under the influence of a rescue from danger (after operations, falling from mountains, after battles, and the like).

IMPOTENCE IN RELATION TO OTHER NEUROTIC MANIFESTATIONS

Impotence is the expression of the inner self, of the unconscious "I will not" which is behind the conscious "I cannot." Ascetic tendencies conceal their religious origin with all manner of esthetic and hygienic masks. If a marked sense of guilt becomes united to an ascetic tendency, there arises the colorful symptomatology of a sexual hypochondriac.

The feeling of inferiority, so universally present in neurotic persons, manifests itself in the impotent man in a variety of ways—he is ugly; he cannot please women; his penis is small (this complaint is often unjustified so far as the actual size is concerned). From fear of defeat he takes refuge in impotence. In the hypochondriac, abstinence, anxiety and a sense of guilt manifesting itself in hidden reproaches and ascetic tendencies are prominent. A transition to these severe cases is formed by those ostensibly clumsy and innocent men who behave "like boobs" with women and are unable to consummate intercourse on account of awkwardness. Often they are latent homosexuals who really seek the anus and consequently are unable to find the introitus vaginae; they play comedy before themselves and the woman in order to spare themselves defeat and sexual fiasco.

Occasionally the penis becomes smaller and temporarily disappears because of retraction which arises from a complete drainage of the corpora cavernosa. Prolonged manipulation and the administration of potassium bromide bring recovery in a few days. The neurotic person will react acutely to such a state, may examine himself in a mirror and observe in terror that he is becoming like a woman. Some will complain: that the spout of semen is too weak as a consequence of a stricture (which is absent); that the testes are too small (which is not the case); that the semen has become too thin, is too small in amount, smells bad, etc.; that the woman will notice a thinning of the pubic hair with disgust; that they have spermatorrhea which worries them (it usually turns out to be phosphaturia), and of other absurd notions as etiologic factors in the production of a temporary or even of a prolonged inability to perform the sexual act. Some fear the sexual act or, though still potent, fear that they will lose potency; to them this is a good reason

to avoid marriage because they could beget only a sickly progeny. They may fear that every sexual act will shorten life; after one coitus they are exhausted and reproach themselves severely, because inhibitions, temporarily overcome by the impulse, have flared up again. In many persons who are abstinent for some time there is a slight spermatorrhea at the end of defecation; it disappears with the resumption of sexual activities. Like all hypochondriacs, he anxiously economizes with his semen as if it will help him to live longer. As time goes by, the genitals and their functions become the center of thought for the hypochondriac. These patients often drive the physician to despair. Suicidal intentions are as frequently expressed as not carried out. Analytic studies reveal that the hypochondriac zone is always an erogenic zone; that the hypochondriacal notion always arises from a sense of guilt, religious or ethical; that the moral dread of the hypochondriac becomes transformed into anxiety concerning the sexual act; that he avoids the physical act because it does not represent his adequate form of gratification. His anxiety is fear of a paraphilia which has been refused recognition in consciousness; therefore, he constantly oscillates back and forth between sexual desire and sexual anxiety. The anxiety is also anxiety for the final Judgment Day which the hypochondriac is trying to forestall through self-dictated punishment and atonement.

Persons with fixations within the family—mother or sister, as the case may be—or family slaves, are often impotent. Sexual intercourse between brothers and sisters is of rather frequent occurrence; the episodes are repressed, but are active in the creation of symptoms; superficially, such patients will claim absolute indifference toward the sister and that nothing ever occurred to them.

It is interesting that in all these cases the patients do not believe in the possibility of a cure; they actually oppose recovery. Behind the disbelief in cure is a secret sexual aim which really means: "Possession of the desired person is the only thing that will make me potent. Since the law and my conscience are against it, and you cannot give me that person, you will not be able to help me. If I cannot have the woman I want, I will forfeit my recovery and renounce all women."

Interesting and significant is the neurotic person's relations to the problem of time. From analyses it has long been realized that the attitude of the neurotic patient toward the problem of time is distinctly disturbed. Time, indeed, has little significance to him; to suit his needs he arbitrarily fixes a situation which prevailed many years before. Reality is often obstinately maintained and fixed long after it has ceased to be a reality. In the neurotic person, psychic phenomena are placed at the disposal of wish fulfilment. He wastes much time before

accomplishing anything. Behind fear of death and end of time is the fear of punishment for death wishes on others. The problem of time is also mingled with that of space. Time becomes an endless path to be traveled. In coitus, especially, human beings sport and reckon with time; they count the minutes and seconds of their sexual acts and either underestimate or overestimate the duration of the performance. The same is true of masturbators, who are chiefly concerned about the intervals between the separate acts and count the days of abstinence. Some believe that retention of semen would prolong life and this they desire at all costs; hence, they practice sexual abstinence. A pollution makes them unhappy; from a hypochondriac tendency toward self-protection they become impotent. The prevalent notion that retention of semen prolongs life is contrary to all clinical experience; in fact, the more one spends it, the longer does he preserve his sexual adequacy

In contrast to the neurotic person who has lost patience and is tired of waiting is the opposite type, for whom waiting is a great pleasure; he puts off a decision in order to prolong the forepleasure, until finally the forepleasure becomes an end in itself. The neurotic person knows only the forepleasure of reality and the afterpleasure of memory. The person who is suffering from ejaculatio praecox is already satisfied with the forepleasure; in sex relations, a man who is potent is also a man who can wait.

The problem of time is mingled with that of impotence. There are many cases that illustrate how the neurotic person plays with time during coitus. Those who manage time like a valuable possession have time for everything and therefore also have time for love. The time in love is never lost, for it is regained through enhanced productive energy. Whoever does not allow himself time for love because he loves time will eventually flee into a neurosis that will disguise the love inadequacy.

THE TREATMENT OF PSYCHIC IMPOTENCE

Most cases of impotence are determined not organically but functionally; the exceptions are those in lesions of the spinal cord, diabetes, malformation or absence of the testes, hermaphroditism, etc. Stekel believes, since they are psychically conditioned, that all forms of mechanical, medicinal and surgical measures must fail,, and that psychotherapy offers the only reasonable approach. Simple suggestion, mechanical intervention, electrical procedures, cold water cures, special diets and all aphrodisiacs may be effective not per se, but because by suggestion they create the idea: "Now, everything will certainly be all right," which overcomes the inhibiting idea. There are cases, nevertheless, in which these therapeutic attempts are absolutely powerless.

As for psychotherapy, it must be borne in mind that false psychotherapy may do injury by nursing a "feeling of illness," which in impotence is the disorder itself.

The more recent the onset of impotence, the easier is the cure. Even a single explanation may work wonders; the less such patients are treated, the better, because every treatment enhances the "feeling of being sick" and has an inhibitory effect on the patient. Secretly, many patients do not wish to get cured. At the same time it must be remembered that rapid results cannot be forced; such advice as to visit a prostitute most often brings only transitory relief. Should a person come to the idea"I am impotent," it will in itself act as a pernicious autosuggestion. On the next attempt at intercourse the idea appears before the act; doubt and fear of ridicule will automatically act as still stronger inhibitions. In such cases the prognosis will depend on whether in any situation the fear and doubt are stronger or weaker than the object that stimulates the libido.

It is hardly possible within the compass of a brief review to give more than the barest outline of the work. The work is richly documented, and for the wealth of clinical details one must go to the original. Stekel is a bit verbose, not infrequently repeating himself, and this with his exuberant literary facility gives one at first the impression of lack of depth. However, this is more apparent than real; when one studies his works carefully, a great deal of sound clinical material can be found. Stekel is above all a clinician who has little use for speculation. His premises are based on solid clinical material, and he does not draw any more conclusions than are justified by the premises. One with an inclination toward the more orthodox analytic procedures is likely to miss some of the fanciful metaphysical speculations with which the recent psychoanalytic literature so abounds; the clinician will not regret it. The present work should be on the desk of every practicing neurologist and urologist whose clientele contains patients who are impotent. The translation is excellent and greatly enhances the value of the work. An index is sorely lacking.

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Abstracts from Current Literature

EXTRAPYRAMIDAL DISEASES OF OLD AGE, WITH A CONTRIBUTION TO THE PATHOGENESIS OF SENILE CHANGES IN THE PARENCHYMA. C. S. FREUND and R. ROTTER, Ztschr. f. d. ges. Neurol. u. Psychiat. **115**:198, 1928.

Freund and Rotter set themselves the task of determining the primary changes in the extrapyramidal system due to old age as distinguished from the changes caused by vascular disease. Investigations of the syndrome of muscular rigidity show that in some cases there is a diffuse senile involutional process, while in other cases multiple foci due to circulatory changes cause parenchymal destruction. The first type have been designated "senile muscle rigidity" (Jakob), while the second have been termed "arteriosclerotic muscle rigidity" (Foerster). Clinically, the differentiation of these two forms is impossible in many cases since the presence of a senile dementia on an arteriosclerotic basis cannot be ruled out. Lotmar, in his work on the basal ganglia, showed that it was not possible to draw a sharp distinction between senile muscular rigidity and paralysis agitans.

The authors report on three cases of arteriosclerotic muscular rigidity. In all three cases the severest changes were in the putamen, and they maintained a vascular distribution. The pallidum was less involved. All three cases showed senile regressive changes in the cortex. Case 3 showed marked destruction of the right cerebral hemisphere, with more marked involvement of the right putamen. The right temporo-occipitopontile tracts were degenerated in this case, but in the other two cases the degeneration of the long projection tracts was negligible. Pontile foci, an old softening in the thalamus, and also in the cerebellum were further complications in the other cases. The olivocerebellar fibers were injured in all cases. Freund and Rotter presuppose that there is a systemic factor at the basis of these observations, and postulate a senile process as the basis of the regressive changes. The diagnosis of arteriosclerotic muscle rigidity is the most commonly diagnosed extrapyramidal disease in the authors' clinic. Foerster described the entity, and in 1909 stated that he thought it was due to disease of the corticocerebellar pathways, and considered that the localized significance of these conditions with a general arteriosclerosis and foci of softening in the cerebrum and brain stem were closely connected. In 1916, he connected paralysis agitans and frontal lobe catalepsy as both due to disease of the frontopontocerebellar pathway. He later changed his views and stated that the parkinsonian syndrome was due to disease of the pallidum, but he still held that injury of the frontopontocerebellar pathway could cause a pallidal syndrome or a similar picture. In the pallidal syndrome he included paralysis agitans, the pure cases of arteriosclerotic muscular rigidity and postencephalitic paralysis agitans. Freund and Rotter question, however, whether there is such a thing as a pure arteriosclerotic muscle rigidity, because many of the cases are complicated by motor disturbances and give rise to mixed pictures. The work of many others, moreover, has shown that the striatum is involved in these cases and often much more than the pallidum. This was so in the cases of Freund and Rotter.

The authors report three cases of parkinsonian-like syndromes with cerebellar signs. In one of these there was involvement of the dentatorubral system, with marked degeneration of the nucleus dentatus. In other respects this case resembled the previous arteriosclerotic group; it showed marked degeneration of the striatum, with less marked involvement of the pallidum. In another case in this group there was symmetrical degeneration of the pallidum, hypothalamus, midbrain and nucleus dentatus. The inferior olives were also involved. Clinically, this case differed from paralysis agitans in that there was a lack of progressive tonus disturbance and the characteristic position of the upper extremities. The question arises in these cases just how to classify them anatomically. Lotmar is in favor of grouping senile muscle rigidity and paralysis agitans together. A review of

the reported cases of senile muscle rigidity, however, shows that while regressive changes occur in the large nerve cells of the striopallidum the interbrain and midbrain remain untouched. In only one case, that of Stief, was there concomitant disease of the substantia nigra, and in the case of Reich-Vogt there was also injury to the corpus Luysii. The senile muscular rigidity, therefore, shows rare implication of the substantia nigra and hypothalamus, and none of the vegetative signs which are part of paralysis agitans. Freund and Rotter state that in senile muscular rigidity the striatum is most markedly involved, then the pallidum, while the substantia nigra and hypothalamus are rarely affected, and vegetative symptoms are usually lacking.

In the three cases last mentioned, there was clinically a combination of extrapyramidal hypertonia and hypotonia, and anatomically a combination of disease of the striopallidal and of the dentatocerebellorubral systems. The question then arises whether and in how far these syndromes influenced one another. Foerster has said that the "pallidal syndrome and cerebellar syndrome are related to one another as positive to negative." For example, in pallidal disease there is a pathologic exaggeration of the normal stretch and postural reflex through the fact that the cerebellar system mediating this reflex has been robbed of an inhibitory effect normally practiced on it by the pallidum. Conversely, with cerebellar disease there is decrease of stretch reflexes, and hypotonia results. The cerebellar system forms a reflex arc the middle point of which is the cerebellar cortex. To this center there stream stimuli from all sides, from the periphery, by the spinocerebellar tracts and the vestibular systems, and from the cerebral cortex by the corticopontocerebellar fibers. The corpus dentatum forms the first station of the efferent tracts, and collects the stimulating stream coming to the cerebellum. From the corpus dentatum the stream runs by the superior peduncle to the red nucleus and thalamus, and each of these nuclei sends crossing fibers to the other. The red nucleus, therefore, has playing on it influences from the cerebellum and thalamus, the latter being the middle station for impulses coming from the cerebral cortex and striopallidum. In the cases of the group mentioned, the influences to the subpallidal nuclei, especially the red nucleus, are decreased by lesions within the striopallidal and cerebellar systems. Consequently, the red nucleus is more or less removed from all inhibitory effect of the pallidum. In a case of Jakob's, in which both red nuclei and the rubrospinal tracts were atrophied, they attribute the clinical picture to the uninhibited play of the pyramidal tracts.

In one of the authors' cases, there was a marked arthritic deformity, which brings up the question of the cerebral origin of arthritic changes. In 1922, Lhermitte reported on the pallidal syndrome of chronic deforming arthritis, and in such a case found marked changes in the striatum and pallidum. Hirsch has called attention to the similarity of chronic deforming arthritis and certain cerebral diseases. He looks on it as an expression of disturbance of tonus and coordinating movements which may be cut off at higher or at peripheral levels. Chasanow has published a report in which he agrees with Lhermitte, and says that arthritic changes must be looked on as a direct result of disease of the striatal septum. On the basis of disturbance in function of the vegetative system, trophic changes are produced in the bones and joints, with the eventual production of arthritis deformans. Freund and Rotter do not agree with this. However, they have had the opportunity of studying many cases of polyarthritis, and several cases of claw hand in paralysis agitans as well as several cases of club foot. They were astonished by the similarity of hands and feet in certain diseases of the joints and cerebral diseases. In 1921, Foerster expressed the opinion that the postural anomalies of pallidal diseases are explainable by the abnormal positions in which the limbs are primarily held. Due to increased tonus and to increased postural tone the limbs tend to hold any given passive position and assume a certain position passively; after a time this gives rise to contractures. In pyramidal diseases also there is a tendency to adaptation and fixation. Hand and foot deformities of cerebral origin are therefore established. In the deformities of this origin the electrical reactions are not changed.

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THE CLINICAL STATUS OF THE "DEGENERATION" PSYCHOSES AND AN ATTEMPT AT A CLASSIFICATION. O. BINSWANGER, Arch. f. Psychiat. u. Nervenk. **83**:299 (March) 1928.

In the present communication, which represents an elaboration of a paper read at the Swiss Psychiatric Association, Binswanger discusses the concept and classification of this disease entity. Within recent years, the author, Kleist, Schroeder and others have reported a series of cases which could best be classified in this group as they seemed to show features altogether without the bounds of any one recognized psychiatric disease entity, and yet presented some points met with in the others. The prominent factor in these psychoses is, according to the author, a constitutional predisposition to certain types of psychopathic reaction patterns. This predisposition is conditioned pregenitally and is either hereditary or possibly acquired by the fetus in its early developmental stages. The author introduces the subject by a discussion of psychic degenerations in general, and starts out with a classification of constitutional types, deviations from which would result in abnormal behavior. There are five such types: (1) the active, with a gay and cheerful disposition, prone to carefree and superficially conditioned activity. (2) The passive, with a pessimistic attitude, somewhat retarded and showing lack of initiative. (3) The emotionally cold, egocentric, strong willed and unscrupulous. (4) The soft sentimental, too easily vulnerable type with a low resistance to psychic disturbances, who are easily influenced by changes in the environment and show a tendency to follow the path of least resistance. (5) The irritable, inflammable types, of which there are two subdivisions: (*a*) the expansive and (*b*) the hypochondriac. In both of these there is a tendency to sudden outbursts of anger or despair, with an aggressive coloring in the first, and a more passive coloring in the second. Exaggerations of any one of these may result in a psychopathic reaction type and these may be either simple psychopathies or degenerative. These psychopathic reactions can be further classified as follows: (1) The hypomanic-megalomanic type, in which on the basis of compensatory mechanisms there is an increased emotional instability. (2) The depressive, which offers the counterpart of the first, with a cloudy, pessimistic attitude toward life. (3) The irritable, expansive person who along with (4) the depressive, irritable person develops on the basis of exaggeration of the fifth constitutional type. (5) A group of types of psychopathic reactions in which one recognizes reaction patterns found in certain well known disease entities such as the hypochondriac, paranoid, epileptoid, hysteroid and schizoid.

The features that characterize the degenerative group of psychopathologic types are to be looked for in the so-called indexes of degeneracy, both physical and psychic. The physical stigmas are not particularly definite nor are they always found, but psychically a group of such characteristics can be recognized in these persons: an instability of emotional expression, an unbalanced mixture of different personality features, disturbance in esthetic, ethical and psychosexual components of the personality, compulsion phenomena, suicidal tendencies, etc. With these characteristics as the most prominent features, the clinical appreciation of such a psychosis also rests on the course of the disease. They occur in the form of episodes with fairly good adaptation of the subject before and after the attack. The absence of any definite defects following an acute attack is characteristic of the disease, although the author admits that some weakening of the resistance to difficulties in life can be observed as time goes on. The actual attack in a person constitutionally predisposed is generally precipitated by some disturbance, either exogenous (reactive type) or endogenous (autochthonous type). The author emphasizes, however, that a clearcut differentiation between the reactive and the autochthonous cannot be made, as in a number of psychoses that seem to be due to exogenous factors only psychic conflicts may be discovered on further study, and vice versa.

With this introduction, the author attempts a classification. He recognizes four major groups. (1) The episodic disease states: (*a*) delusional episodes which consist in isolated occurrences of delusional formation with complete disappearance after a short period of time, and with practically no postpsychotic defect; (*b*)

episodic dream states. (2) Fragmentary psychoses of sudden onset and subacute course: (*a*) acute states of primary incoherence and excitement; (*b*) paranoid states; (c) catatonia-like psychoses. (3) The polymorphous degenerative psychoses. (4) The "dégénerés superieurs" (Magnan). Under this group are included moral insanity, sexual perversions, degeneration tic diseases, drug addiction, etc.

As the most important etiologic factor, the author stresses the hereditary predisposition. He is of the opinion that this is probably expressed in some organic defect, and mentions the possibility of vascular anomalies in the brain. Appended to this article are some remarks by Rohde who has carried on some investigations with the author. Rohde stresses the rôle played by the endocrine glands in conditioning the psychoses. The disturbances in the endocrine glands, according to his opinion, are probably influenced by hereditary factors.

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XANTHOCHROMIA OF THE CEREBROSPINAL FLUID. D. A. SCHAMBUROV and S. L. LURJE, Ztschr. f. d. ges. Neurol. u. Psychiat. **114**:602, 1928.

Schamburov and Lurje divide xanthochromia into two groups: (1) hemorrhagic xanthochromia, caused by hemorrhage in the subarachnoid space, and (2) pressure xanthochromia, caused by compression of the blood vessels in the spinal cord and meninges and by the formation of a block in the subarachnoid space. Clinically, it is important to know which one of these types of xanthochromia is present, and this is determined not only by the clinical features, but also by the accompanying observations of the spinal fluid. Hemorrhagic xanthochromia is found in traumatic and infectious changes of the brain and spinal cord, hemorrhages into the brain, brain tumors, epilepsy, etc.

Xanthochromia in meningitis is accompanied by: (1) the presence of erythrocytes; (2) pleocytosis, the degree of this bearing no relation to the degree of the xanthochromia; (3) a moderate increase in albumin; (4) a coagulum at times. The xanthochromia occurs during the course of the disease and finally disappears. In a few cases the authors saw it recur.

In hemorrhages, in addition to the xanthochromia there is slight increase in albumin, a mild globulin increase and an insignificant pleocytosis, which is not always constant. The pleocytosis disappears with the coloring of the fluid, and is not caused by inflammation of the meninges.

Xanthochromia is found in a few cases of brain tumor and is caused by hemorrhage into the tumor. It is accompanied by great increase in albumin and in the number of erythrocytes. Xanthochromia in epilepsy is also caused by small hemorrhages in the meninges.

Hemorrhagic xanthochromia is characterized by: (1) the presence of erythrocytes and their derivatives—hemoglobin; (2) change of color of the fluid, first to brown red, then greenish yellow, and finally colorless; (3) no tendency to massive coagulation; (4) the albumin content is not markedly elevated, and never reaches the height in compression xanthochromia; (5) pleocytosis is found in meningitis, but is not present in the other forms.

Pressure xanthochromia is most frequent in compression of the spinal cord and in interruption of the circulation of the subarachnoid space. Sicard first described such cases; Mestrezat first explained the significance of the xanthochromia, and Ayer produced xanthochromia experimentally by compression of the spinal cord with paraffin. Block may be produced by various factors, such as tumor, dislocation of the vertebrae by tuberculosis or trauma, vertebral tumors, hypertrophic processes in the spinal meninges and by adhesions. The degree of xanthochromia is dependent on the degree of compression of the cord and meninges. The more complete the compression, the more marked is the xanthochromia. The characteristics of the spinal fluid in pressure xanthochromia are: (1) an increase in albumin content without increase in cells; (2) lack of discoloration of the fluid above the compression, with either normal properties or a slight increase of protein; (3) in most cases a coagulum of a massive degree forms in the

xanthochromic fluid; (4) pleocytosis can be demonstrated in those cases due to meningitic adhesions. A few authors assume that xanthochromia is typical of a compression in the lower parts of the spinal cord. Raven analyzed 145 cases in the literature, and found that this was not true, but he concluded that xanthochromia was more frequent the lower the compression lay in the cord. The authors observed xanthochromia in tumors of the cervical cord, as well as in tumors in other parts of the spinal cord. On the other hand, they found that a compression of the thoracic or lumbar cord regularly caused xanthochromia while one in the cervical cord did not always cause a change in color. When xanthochromia is present in cervical cord compression, it is less intense than in other areas of the spinal cord.

The origin of the xanthochromia is attributed by some to the blood pigments. Babes asserts that it is due to the lipochromes of the lutein group which are frequently encountered in different exudates. The blood plasma is said to be a source of the xanthochromia. Schamburov and Lurje state that the xanthochromia is definitely derived from the blood pigments. Leschke showed that bilirubin is present in xanthochromic fluid. Other studies have demonstrated that blood pigments are responsible for the color in xanthochromic fluid. The xanthochromia follows from a definite series of events which occur after compression of the cord. There is disturbance in the circulation, stasis in the vessels, edema in the meninges, filtration of fibrin into the meninges and fluid, and xanthochromia. Xanthochromia may occur above the area of compression, as shown by Cushing and Ayer, who found it in five cases of tumor of the cauda equina above the area of compression.

ALPERS, Philadelphia.

SURGICAL LIABILITIES AND THE DANGERS OF BRAIN PUNCTURE. Editorial, J. A. M. A. **91**:964 (Sept. 29) 1928.

Long hollowed needles by which slender cylinders of tissue are removed for study are inserted in various directions and sometimes to great depths in the brain, before and after decompression operations. By examination of the tissue microscopically, diagnosis of the disease is often correctly made. Brain puncturing is also done for radioscopic ventriculography and for other purposes. These measures are usually to determine and aid subsequent intracranial surgical operations. Serious consequences and even death occasionally follow these exploratory ventures. No doubt the desperate condition of the patient demands his exposure to the risks; however, only those with broad experience in neurologic surgery possess any competent appreciation of the dangers of puncturing the brain. The information available is restricted within narrow circles, since most published reports are devoted to surgical triumphs rather than to unfortunate outcomes or to mortality.

The state of affairs here discussed need not be considered as applying exclusively to puncturing the brain as an aid to diagnosis. The length of time required for the medical profession at large to become acutely conscious of the indications and contraindications for many other operations has generally been too long. Indeed, one of the great problems of medical practice is the length of time required for new information to filter into the hinterlands of the medical profession. Emergency operations always have been and always will be required in outlying districts. In some measure, the public must always deal with an inaccessibility to surgical skill such as alone may prove effective. To such difficulties there is added the burden of a dearth of exact information of the liabilities of surgery as practiced by leaders with all modern facilities. As a consequence of these shortcomings, it is natural that a sense of approval is aroused whenever careful studies appear of the conditions that have caused surgeons their greatest anxiety, bitter disappointments and failures. The courage and humanity exhibited in opening for others records of mistakes and calamities with suggestions for their avoidance serve to remind one that "spirits are not finely touched, but to fine issues." And the gratification provoked by publications of investigations of this order is usually keen because they commonly are from the élite among the surgeons, men replete with experience.

For these reasons, commendation in this place is clearly indicated for the thoughtful review by Heymann (*Nervenarzt* **1**:27 [Jan.] 1928) of the dangers of brain puncture. Among other dangers, he considers sudden huge intraleptomeningeal hemorrhage; disease of the cerebral vessels; the ease with which bleeding occurs from the brain tissue about foreign bodies, tumors and abscesses even when no large vessel is injured; the explosive hemorrhage following puncture of tumors; the accentuation of symptoms present before puncturing, and hemiplegia from the acute localized edema which follows a sudden relief of pressure on the internal capsule. Serious symptoms seldom follow puncture of the brain through practically intact craniums. When decompression was made of one brain by the customary resection of a bone flap, a profuse arterial hemorrhage occurred from needle wounds made three days before. Monoplegias from local edemas may occur when the edematous and punctured regions are far apart.

Heymann's desire to make all these matters plain is extended to descriptions and illustrations of the brains and what was found by Westenhoeffer, who made the postmortem examinations. There are, however, no accounts of the large hemorrhages that distend all the ventricles and cause speedy death when vessels of the choroid plexus are wounded inadvertently by punctures. This outcome is not by any means unknown, but unfortunately there is no way of obtaining a fair index of its frequency. Emphasis is given by the author to the greater ease with which bleeding takes place from the brain when there are generalized infections either within the cranium or in the body as a whole, and toxins have modified the integrity of the walls of small blood vessels. He refers to observations made by others of this result of infection, in the disposition to hemorrhage from the needle wounds of lumbar punctures. The treatment of these and of numerous other phases of the subject denote a great experience. Immeasurable benefits would accrue to the younger generations of surgeons and a more correct idea of the limitations of operative measures would be available, if more eminent surgeons would review, in the light of later knowledge and improvements in technic, their practices of previous years. Large or unusual vision is not necessary to realize that such presentations would add to rather than diminish the prestige of their authors.

CHAMBERS, Syracuse, N. Y.

THE PATHOGENESIS OF ELECTIVE DISEASE OF THE CORNU AMMONIS. UCHIMURA, Ztschr. f. d. ges. Neurol. u. Psychiat. **114**:567, 1928.

Since the work of Sommer on the changes in Ammon's horn, this region has been the subject of many investigations. Bratz laid the foundation for modern investigations of this region and directed his attention more to its involvement in different diseases than to the microscopic change present. Since then many contributions have been made. Uchimura examined the cornu ammonis in thirty-nine cases including epilepsy, idiocy, pertussis, pantopon poisoning, traumatic epilepsy, carbon monoxide poisoning, tuberculous meningitis, arteriosclerosis, cerebral syphilis and paresis.

The question is whether the changes in the cornu ammonis are pathognomonic for different diseases. To answer this Uchimura studied fresh material with changes in the region concerned in different diseases. The progressive development of these changes is also of importance. In three cases in which the patients died two and one-half, three and four days after pantopon poisoning, pertussis and carbon monoxide poisoning, there were certain conditions in common. In every one Sommer's sector was severely damaged, while the ganglion cells there showed a characteristic ischemic change. In the oldest case only were the glia cells degenerated. Uchimura points out that here one has cases with early characteristic changes in Ammon's horn, and there are undoubtedly cases in which the changes are still earlier. He cites such a case, one of epilepsy, in which there was no severe disease of the ganglion cells as in the preceding cases, but with focal loss of cells here and there. There was an active glial reaction and rod cell formation, leading to the assumption that a severe destructive process had played itself out. He describes similar observations in a case of tuberculous meningitis,

showing early changes in the cornu ammonis. The latter two instances probably represent a pre-stege of the conditions described in the first three cases. This intimate relation between the ischemic ganglion cell disease and the appearance of rod cells in the pathologic changes in Ammon's horn is shown clearly in the following case: This was a case of tuberculous meningitis which showed fairly advanced ischemic ganglion cell disease of Sommer's sector, with active glial satellitosis, and the rich occurrence of rod cells in place of the destroyed reticulum. This case, therefore, combined both aspects of the aforementioned cases, and represents a later stage in the process of the pathologic change of the cornu ammonis. In a little more advanced cases the microscopic picture was similar to that of the last case, but here the process was slightly more advanced, with fat Abbau by the rod cells, and the occurrence of protoplasmatic astrocytes as a sign of a reparation process. In a case of arteriosclerosis Uchimura describes a much advanced process — extensive disease of the pyramidal layer, marked ischemic cell disease, active and advanced fatty degeneration, glial fiber production in the projections of the astrocytes and active glial proliferation in the whole region.

Uchimura's material comprised circulatory, epileptic and other diseases. In all these conditions it is surprising that the observations were much the same. The process was the same in all cases, and the differences were due to different phases of one process. The injury of Ammon's horn may come on acutely, even in a period of one or two days, causing the ischemic cell disease and other changes noted. The destructive and preparatory process in the cornu ammonis goes on and on, and leads finally to sclerosis. The nature of this process is dependent on circulatory disturbances in the nervous system, and its most striking feature is in every instance the ischemic cell disease. This type of cell change was first described by Spielmeyer and is seen in nerve cells in which the blood supply has been shut off more or less completely. Possibly the most striking feature in the pathogenesis is the local electivity of the focus. Sommer's sector is most markedly degenerated in every case. Many authors look on this simply as a locus minoris resistentiae. Uchimura believes it is dependent on circulatory factors, however, and that the artery supplying this sector is an end artery, and hence degeneration is complete when this sector is involved. The same conditions which are present in vascular disturbances are found also in general circulatory disturbances, air and fat emboli in the cerebral vessels, and even in arteriosclerosis. The disease process of ischemic cell disease is seen in the fresh and acute cases, and progresses into a more marked involvement in the older cases. The process involves not only the ganglion cells, but also the supporting structure of the nervous system.

ALPERS, Philadelphia.

TUMORS OF THE FRONTAL LOBE OF THE BRAIN. J. PURDON MARTIN, Brit. M. J. **1**:1058 (June 23) 1928.

CASE 1.—The onset of symptoms occurred with: a severe convulsive attack; slight but increasing mental changes of the nature of a loss of initiative and memory, increasing reliance on others, insufficient realization of his condition and euphoria; tremor of the hands and voice, not constant and not noticed when the patient was in bed; headaches; further convulsions and frequent petit mal attacks. A year after the onset there were: rapid diminution of vision and partial atrophy of the optic nerves, and flexor plantar responses of exaggerated briskness. The necropsy confirmed the presence of a tumor in the left frontal lobe. A noteworthy negative feature was the absence, until the last stages of the illness, of practically all abnormal motor phenomena except tremor; symptoms in the olfactory system or speech and ataxia were not present.

CASE 2.—There were: gradual development of mental symptoms such as loss of mental sharpness, stupid mistakes, inability to supervise others; loss of memory and, later, ideational apraxia; headaches; tremor of the hands like that in general paresis; tendency to fall backward when standing and to deviate to the right when walking; excessively brisk flexor plantar responses; slight left facial weak-

ness at rest and slight extensor plantar response on the left side with persistent stimulation. The presence of a bilateral tumor of the frontal lobe was verified after death. The absence of definite changes of the optic disk and of vomiting, of olfactory symptoms, aphasia and all kinds of paralysis should be noted.

CASE 3.—A woman, aged 58, suffered from unusual mental depression for several months and then had a convulsive attack; after an interval of two months a series of very severe convulsions occurred. Mental changes then became apparent: confusion, loss of memory, liability to make mistakes in everyday duties and abnormal reliance on others; headache became frequent; tremor of the hands was observed. Toward the end, the plantar responses became indefinite. After death, a tumor was found involving both frontal lobes. The absence of signs and symptoms in the olfactory and visual systems and the absence of aphasia and of paralysis of every kind is noteworthy.

Local pains, such as pain over the left eye, which occurred in case 3, are probably due to a local stretching of the dura or to erosion of bone. Convulsions were an early symptom in two of the three cases and were the first definite indication of disease. They occurred before any other sign appeared, except perhaps vague mental changes. They were generalized and associated with prolonged headache and sometimes with continued unconsciousness. Attacks of such severity and of such absolute suddenness are rarely caused by tumors in other parts of the brain. Mental alterations, while not specific in the case of frontal tumors, are of localizing value when evidence of increased intracranial tension is lacking. The most constant psychic modification, met with in all these cases, is an abnormal submissiveness or docility and a childlike reliance on others. Loss of memory is frequent and confusion may occur. Incontinence in two of these cases was evidence of dementia and not of paralysis. Tremor was the only observed clinical sign, except the mental changes, which was common to all three of these cases. Tremor in tumors of the frontal lobe is generally accepted as homolateral. In two of these cases it was bilateral, the tumor being bilateral also, and in the third case, although the tumor was confined to the left side, the tremor affected both sides to some degree.

In one case, the flexor plantar response was indefinite. In the other two, exaggerated flexion occurred, which was not due to excessive sensitiveness of the sole of the foot as no voluntary withdrawal took place. In both cases, this phenomenon was bilateral and in the first case, in which the tumor was on the left side, stimulation of the right sole caused brisk flexion not only of the right big toe but of the left one also. Stimulation of the left sole caused flexion on the left side only. In one of these cases with exaggerated flexion, extension could be produced by Oppenheim's method; in the other, repeated stimulation seemed to tire the flexor response which was replaced by extension. Preponderance of tremor may be the only evidence of the particular side of the brain involved.

PETERSEN, Montreal.

ENCEPHALITIS IN PUERPERAL DISEASES. HANS ERHARD BOCK, Ztschr. f. d. ges. Neurol. u. Psychiat. **115**:173, 1928.

Bock is not concerned with the encephalitis purulenta of older writers, which is characterized by small inflammatory foci caused by emboli of the causative agent. He is concerned, however, with a type of encephalitis much less common in the medical literature, an encephalitis of a noninflammatory or toxic nature. Now and then in pregnancy, abortion or during the puerperium an encephalitis develops. These cases are usually explained on the basis of toxins due to the pregnancy, but this has not been established. Bock reports three cases of encephalitis occurring during pregnancy and the puerperium. Case 1 concerned a woman, aged 34, who had an incomplete abortion at four or five months, followed by cerebral symptoms consisting of confusion and excitement, and ending in death in three days. Necropsy showed hemorrhages in the suprarenal glands and the presence of *Bacillus coli* in the heart blood and spinal fluid. Microscopic examination revealed gram-negative bacilli in the suprarenals, skin, vessels and brain.

Of particular importance was the presence of an encephalitis due to a colon bacillus, which involved almost all the gray matter of the subthalamus and especially the tegmentum and thalamus. The vessels showed cellular proliferation, and the ganglion cells were degenerated. Fibrin thrombi were seen in the vessels, and perivascular infiltration of lymphocytes was also found, with an occasional polymorphonuclear cell. The glia showed a tendency to regressive ameboid changes. Bock summarizes the case as one of sepsis in the mother, leading to metastases in the skin, suprarenals and brain. The cause of these changes was *Bacillus coli*, which was found in the vessels of the brain, and in the blood and spinal fluid. Bock says that encephalitis due to a colon bacillus is extremely rare and has never before been reported. Meningitis of this etiology has occasionally been mentioned, but not an involvement of the brain parenchyma. Fraenkel, in a discussion of observations of lesions of the brain caused by *Bacillus coli*, mentions fibrinous thrombi, intravascular hyaline bodies and areas of coagulation necrosis in the cortex and white matter. He did not speak of this as an encephalitis. Bock suggests that his case of encephalitis is not comparable to the type of encephalitis produced by the streptococcus or staphylococcus, and should rather be classed as "encephalosis." In typhus fever and dysentery there are changes in the brain which belong to the encephaloses. Wohlwill has described degenerative foci and glial proliferation in a case of encephalitis due to typhus fever. Lotmar found similar changes in experimentally produced dysentery. Toxins may produce an effect on the brain, as in another case of Wohlwill's in which *B. coli* was found in the spinal fluid, but not in the sections of the brain. The changes of the brain were therefore ascribed to endotoxins, and Bock states that, in addition to the direct effects of the bacilli, the changes in his case were due also to endotoxins produced by these bacteria.

Case 2 concerns a woman, aged 32, who immediately after a soap and water injection into the uterus, developed fever, loss of consciousness, convulsions and died in twenty-four hours. Necropsy showed small hemorrhages in the white matter of the brain. Microscopically, an encephalitis was found. This was characterized by proliferative changes in the vessels, perivascular infiltration consisting of leukocytes and lymphocytes, and marked evidence of ameboid glia cells. Small perivascular hemorrhages in the brain completed the picture. Bock discusses at length the occurrence of encephalitis due to air emboli. In this case there was a patent foramen ovale, and Bock looks on it as an irritative encephalitis caused by air emboli which were permitted to enter the cerebral circulation by a patent foramen ovale.

Case 3 occurred in a woman with syphilis who had a recurrence of syphilitic meningo-encephalitis under the influence of a febrile abortion.

ALPERS, Philadelphia.

PUPILLARY CONVERGENCE AND LOOKING AT NEAR OBJECTS. LUDWIG EIDELBERG and ALFRED KESTENBAUM, Jahrb. f. Psychiat. u. Neurol. **46**:1, 1928.

The authors studied experimentally the phenomena of pupillary convergence, accommodation and looking at near objects. They reach the following conclusions:

1. Pupillary motility is closely associated with convergence and never occurs in the absence of convergence.

2. Accommodation is associated with contraction of the pupil only when the subject converges at the same time that he attempts to accommodate.

3. The impulse to look at near objects does not produce pupillary contraction unless the person converges at the same time; on the other hand pupillary contraction occurs also without looking at a near object during convergence.

4. The close association between pupillary motility and convergence gives rise to an important pupillary symptom during paralysis of convergence, namely, sudden pupillary dilatation on reaching the near point of convergence.

5. During paralysis of convergence the near point for convergence is, with striking frequency, the same as the near point for accommodation.

6. It would seem that during the formation of an image of an object on identical retinal areas in both eyes there also occurs the possibility of a differentiation in the cortex as to the respective eye in which the image is to be formed. If this is so, Hering's conception of the "cyclops" eye is not always tenable.

7. The extrafoveal formation of the image of the "interesting" object is the exciting stimulus for convergence.

8. The dispersion of the image of the "interesting" object is the exciting stimulus for accommodation.

9. As the same stimulus may give rise at one time to accommodation and at another to relaxation of accommodation, the reaction of accommodation may be regarded as a sort of "groping" reaction rather than a reaction the maximum intensity of which is suddenly increased. (When the image of the "interesting" object appears in the dispersion field, the person accommodates only slightly; if this degree of accommodation is found to be useful, the dispersion center becomes narrower and the person accommodates more. Should, however, the original accommodation not have had the desired effect and the object looked at still not remain clear, the individual would attempt to obtain a clearer view by relaxing the accommodation.)

10. Convergence and accommodation are "semi-reflexes" subject to a control organ (mechanism) which regulates the inhibition according to the psychic value of the presenting objects.

11. Convergence and accommodation represent a variety of conditioned reflexes, in Pavlov's sense, but are mutually dependent on each other.

12. In contrast to convergence and accommodation, pupillary motility while looking at near objects cannot be elicited reflexly (optically); it is a purely associated movement.

13. In contrast to the pupillary reaction to light, miosis during convergence is a prolonged phenomenon lasting as long as the individual continues to converge.

14. As pupillary motility represents purely an associated movement and is actually dependent only on convergence, it has nothing to do with looking at near objects and accommodation. The only proper designation for this phenomenon is "convergence reaction of the pupil," and the terms "reaction of the pupil while looking at near objects" or "reaction to accommodation *and* convergence" are to be discarded.

KESCHNER, New York.

SOME PROPERTIES OF THE SEPARATED ACTIVE PRINCIPLES OF THE PITUITARY (POSTERIOR LOBE). J. H. GADDUM, J. Physiol. **65**:434 (Aug.) 1928.

Gaddum has presented the results of investigations on the supposedly purified preparations "vasopressin" and "oxytocin" recently isolated from the posterior lobe of the pituitary gland by Kamm, Aldrich, Grote, Rowe and Bugbee, and prepared by Parke, Davis and Co. He found that vasopressin contains 25 international standard units per cubic centimeter and oxytocin less than 1 unit per cubic centimeter. The rise in blood pressure produced by large doses of oxytocin was more prolonged than that due to small doses of vasopressin. One cubic centimeter of oxytocin contains from 12 to 15 units of oxytocic activity. Vasopressin contains less than 1 unit per cubic centimeter.

The diuretic action is produced by much smaller doses of vasopressin than of oxytocin. The diuretic effect of large doses of oxytocin, on a cat under ether, was, like the pressor effect, more prolonged than that of small doses of vasopressin.

Vasopressin did not show a depressor effect on a cat, even when given in repeated doses. One cubic centimeter of oxytocin (containing 12 units) did not show a depressor effect when given with soda. On the other hand, when 12 units of untreated oxytocin solution were injected into a cat in which the blood vessels were still in high tonus as the result of several large doses of vasopressin, a definite fall of blood pressure occurred. The effect is possibly analogous to the depressor action of pituitary preparations on the fowl. It has been investigated by Hagben

who showed that the substance producing it is present in the pars neuralis and, to a less extent, in the pars intermedia, but not in other tissues. He also showed that it is destroyed by treatment with sodium hydroxide, and is accordingly not histamine. Gaddum found that a fall of arterial blood pressure was produced in a fowl under ether by large doses of vasopressin and of oxytocin, and also that oxytocin was active in much smaller doses than vasopressin. These two depressor actions, on the cat and on the fowl, are the only two actions, apart from that on the uterus, which have been found to be produced by smaller doses of oxytocin than of vasopressin, and it is possible that they are both due to the oxytocic principle itself. This would accord well with the fact that such effects are produced by Abel's purified preparations, in which the oxytocic titer appears to be extraordinarily high.

It was found that, though both preparations produced shortening of an isolated loop of the rabbit's intestine and an increase in peristalsis, vasopressin produced these effects in smaller doses than oxytocin. This effect is rather irregular. The colon appeared to be more sensitive than the ileum, and the ileum more than the jejunum. Previous work on this question is summarized in a paper by MacDonald, who found that pituitary preparations had little if any specific effect on the isolated intestine of the cat. Gaddum confirmed this observation.

The activity of the different preparations on frog's melanophores does not bear a constant proportion either to their pressor or to their oxytocic activity. The dilator action on the melanophores is probably due to a separate substance, although some of this is present in vasopressin.

Gaddum concludes that "oxytocin" has, in addition to its action on the uterus, a depressor action on the fowl, and, in certain circumstances, on the cat. "Vasopressin" has, in addition to its effects on the blood pressure and on the kidney, a specific stimulant action on the bowel of a rabbit and a dilator action on the melanophores of the frog. The latter effect is apparently due to a different principle, so that vasopressin is not as yet a physiologically pure preparation.

ALPERS, Philadelphia.

THE OCCURRENCE OF HALLUCINATIONS IN PARESIS. T. JOHANNES, Arch. f. Psychiat. **82**:619 (Feb.) 1928.

The cases of 2,100 patients with paresis who were admitted to the Munich clinic during the period from 1905 to 1922 were studied with the purpose of determining the frequency and nature of hallucinations in this disease. In most of the cases only the records were available. Some of the patients, however, were examined by the author personally. Definite hallucinatory experiences were found in 11.9 per cent of the cases. The author divides these into auditory, visual, haptic, gustatory and olfactory. In some records the fact of "hallucinations" was mentioned without further description. The percentage found by the author is similar to those of Kraepelin and Obersteiner. Other authors, however, differ in their reports; Ziehen found hallucinations in 25 per cent of his cases; Jahrmaerker found them in few cases, and Plaut found definite hallucinations in only 3 of 715 patients. Plaut, however, examined patients who were mentally tractable. He admitted that in the confused and delirious phases of the disease, hallucinations are much more apt to occur. There was no relation between the sex of the patient and the occurrence of the hallucinations, nor was there any particular relation to the duration of the disease. Some authors believed that hallucinations in paresis were probably indicative of a process more closely allied to cerebral syphilis. This, however, Johannes could not substantiate. Of the different types of paresis, the depressive was the one in which hallucinations were found most frequently; they occurred in decreasing order in the circular, agitated, catatonic and taboparetic types. Some authors thought that the occurrence of hallucinations in paresis was dependent on previous abuse of alcohol. Johannes finds, however, that this has been somewhat exaggerated and that hallucinations occur in patients who have not used alcohol previously. The most frequently occurring were the auditory;

second were the visual hallucinations, and in a number of cases these two were combined. The personality previous to the onset of the disease seemed to have no definite relation to the development of hallucinations, and only in one fourth of the patients in whom hallucinations were found was there anything in the personality to point to abnormal traits. The author thinks that at present no definite causative factors for the occurrence of hallucinations can be brought out. There did not seem to be any particular hereditary taint. There was no evidence for the possibility of primary organic involvement of the organs of special sense as causative of the development of hallucinations.

At the end of the article Johannes discusses the question of the diagnosis of hallucinations and the bearing it has on the fact that different authors differ in their statistical reports in cases of paresis. Hallucinatory experience is one which at present is not altogether clearly defined from pseudohallucinations and even from normal experiences; the percentage of definite hallucinations will shift from one extreme to the other, according as the observer is more or less strictly objective.

MALAMUD, Foxborough, Mass.

DRAINAGE OF THE CISTERNA PONTIS LATERALIS IN OTOGENIC MENINGITIS. ALFRED LEWY, Arch. Otolaryng. **7**:614 (June) 1928.

The author gives a short account of the history of this operation and "is unaware of any reports of this operation in the American literature." He has overlooked the reports of the operation by Eagleton. He quotes Goerke as follows: "After the radical mastoid operation is performed (all his patients had chronic suppurations; the complete radical operation may not be necessary), the dura of the middle and posterior fossae is uncovered over a considerable area, the operator going back of the sinus in order to get sufficient operative space and to permit some displacement backward of the cerebellum. The bone in front of (mesial to) the sinus and behind and above the facial ridge is then chiseled away. If the labyrinth is infected, the operation is simplified by going through this structure. Then with a septal elevator, he separates the dura from the posterior surface of the petrosa until at the meatus auditorius internus, the cushion-like projection of the cisterna can be seen."

The case of a child with otitic meningitis following chronic otitis is reported. "The spinal puncture did not elicit any fluid," so that one has no way of knowing whether there was any active infection in the meninges, although the author reports that on opening the cisterna pontis lateralis, a flow of curdy pus was obtained. The child recovered.

In the second case, spinal puncture revealed a turbid fluid under pressure. The cells numbered 9,280 but a bacterial count was not made. The patient died.

The reviewer feels that neither of the cases reported in the aforementioned article are of statistical value, because, as the author has noted in his comment, "The laboratory investigation was faulty," there being no reports of culture or bacteriologic studies.

"The operation is distinctly an otologic procedure. It appears to be a logical approach for drainage in otogenic meningitis, and perhaps for other types, with a reasonable hope for recovery if the infection is still limited to the posterior fossa, although beyond the ear spaces. Undiagnosed depots of pus may be disclosed, and if the operation cannot cure patients with generalized forms of the condition, at least the persistent cerebrospinal drainage seems to relieve suffering and may obviate the necessity of repeated spinal punctures. The Haynes' operation necessitates a separate approach at the foramen magnum.—Perhaps Portman's saccus operation will prove to give sufficient access. The dura is easily separable until one nearly reaches the cisterna, but pathologic conditions may change this. Incidentally, on the cadaver, the jugular bulb was accessible in front of the lateral sinus without endangering the facial nerve."

HUNTER, Philadelphia.

THE PALPS OF LAMELLIBRANCHS AS AUTONOMOUS ORGANS. SAMUEL A. MATTHEWS, J. Exper. Zool. **51**:209 (Aug. 5) 1928.

The palps of *Anodonta* are four in number, one pair on each side of the region of the mouth. The lateral face of each outer palp and the medial face of each inner palp are smooth. The contiguous faces of the two palps of a pair are provided with numerous transverse ridges. The smooth face of the palp is provided with a low cuboidal type of epithelium which is only sparsely ciliated. The epithelium on the ridged surface of the palp is made up of tall columnar cells that are well provided with cilia. Two sets of muscle fibers have been found in the palp, parallel to and immediately underlying its smooth face. A shortening of these fibers causes the palp to curl. Another set of muscles is associated with the ridges and is responsible for movements which they exhibit. The individual muscle fibers are uninucleate and without cross-striations. The connective tissue of the palp is provided with large numbers of elastic connective tissue cells. A definite layer of these fibers lying under the ridges serves to antagonize the muscles that produce curling of the palp. Blood is sent from the heart to the palps by way of the anterior aorta and the pallial, tentacular and velar arteries.

The palps are innervated by a branch from the cerebral ganglion. This nerve runs backward from the ganglion to form a plexus between the two palps of a pair. From this plexus several fine nerves are sent into each palp. In addition to these fibers, intra vitam staining with methylene blue (methylthionine chloride, U. S. P.) has demonstrated numerous epithelial sensory cells which are connected with a subepithelial nerve net. This nerve net has a functional connection with the fibers that connect the palp with the cerebral ganglion. The palp responds to mechanical, electrical and chemical stimulation by curling from posterior tip to base. If the stimulation is strong, the palp also shows a wrinkling of its free ventral edge. In all responses the smooth face of the palp is concave. Unrolling of the palp is slower than curling and is produced by the layer of elastic connective tissue fibers under the ridges. The free tips of the palps curl rhythmically, but only to a slight degree. Such rhythmic movements occur about twice a minute. Palps will respond to stimulation by light even when the intensity is as low as 0.6 of a meter candle. The advantage of such reactions to the animal is dubious. The high degree of autonomy which the palp exhibits is due to its intrinsic nervous mechanism, a nerve net.

WYMAN, Boston.

SHYNESS. F. A. HAMPTON, J. Neurol. & Psychopath. **8**:131 (Oct.) 1927.

Shyness is so common that often it is accepted as something inborn, as a characteristic part of the charm of youth, of a certain fineness of character. As the cause of a great deal of mental discomfort, however, shyness is deserving of more attention. McDougall has suggested that schizophrenia is essentially an exaggerated degree of what, in normal people, one calls embarrassment. In certain cases of shyness one sees an habitual smile, in others a mask-like expression. The resemblance to schizophrenia, however, does not extend to the emotions; shy people are capable of great depth of feeling.

It is suggested that the shy person in general suffers from a conflict between the urge to reach upward to the normal level from a position of imagined inferiority and the deterrent fear of failure. The feeling of inferiority, to which this conflict in shyness is attributed, is of the kind which Adler has described and emphasized. It is never one that the shy person admits to himself. An inferiority that cannot be concealed, such as an obvious deformity, seldom causes shyness. The feeling of inferiority may have originated as a sense of cowardice, an inability to play games, a real or fancied absence of physical attractiveness, or as a result of comparison of self with a superior older brother. Most of the reactions of shyness are due to fear of being looked down on, a result especially dreaded by the shy person since it would confirm the suspicion of inferiority which he dimly feels but hopes is unfounded. A meticulous attention to behavior results in extreme selfconsciousness which, however, is not the same as shyness.

A well dressed woman may be exquisitely selfconscious and not shy. Much of the painful feeling of shyness may be due to the inhibitions of the conative side of fear. Blushing is an occasional accompaniment of shyness, but is a typical manifestation of anger. It represents resentment against the person who causes embarrassment. There appears to be some relation between shyness and the commonest form of stammer. The former might be compared with a conversion hysteria and the latter with an anxiety neurosis. An advantage of shyness is suggested by La Rochefoucauld's observation that a sure way to predispose any one in our favor is to appear at a disadvantage before him.

As to treatment, the magic formula which will impart selfconfidence is yet to be discovered. Suggestion may help. But the surer and more satisfactory method of treatment is to help the patient trace the source of his feeling of inferiority; when this is fully disclosed, he is seldom unable to deal with it effectively.

FAVILL, Chicago.

A STUDY OF CAUSATIVE FACTORS IN THE DEVELOPMENT OF CRIMINAL TENDENCIES. ERWIN P. HELLSTERN, Arch. f. Psychiat. **82**:791 (Feb.) 1928.

Hellstern discusses the probable causes of criminal tendencies on the basis of the study of 200 cases. The study is concerned particularly with the early environment and development of the criminals and the manner in which these could condition criminal tendencies. In most of these cases an analysis of the personality and early environment were undertaken, and cases that were particularly typical are reported and abstracted.

The author comes to the following conclusions: In a great majority of criminals the beginning of the criminal career dates to an early stage of development (from 13 to 30 years). The criminal tendency in early life seems to depend on a psychopathic predisposition in the personality of the subject and is enhanced by poor social conditions. In a great many cases the parents show some psychopathic trends (alcoholism, especially of the father, quarrels between the parents, criminal tendencies in the parents themselves, etc.). In other cases the early loss of the parents, especially of the mother, seems to condition a criminal career. Illegitimate children appear to be especially predisposed. There is no doubt but that heredity plays a great rôle, although it is hard to decide whether the frequent occurrence of criminals in the same family depends on hereditary transmission or on early environmental influences.

These considerations, as well as the results of studies by other authors, would prompt Hellstern to suggest the possibility of ameliorating conditions by the introduction of efficient social hygienic measures. Special educational institutions for children who show tendencies of this type should be established, and the period of education in such institutions should be extended to the age of 18 years. He thinks that when children are dismissed from these institutions at an early age and have to adapt themselves to a new environment before they are mature, the work done by the institution is not sufficient to keep them from going astray. After their dismissal they should still be assisted in obtaining a position and in adapting themselves to their environment.

MALAMUD, Foxborough, Mass.

THE INFLUENCE OF THE VAGUS ON THE ISLETS OF LANGERHANS: PART III. FURTHER EXPERIMENTS ON VAGOTOMY. G. A. CLARK, J. Physiol. **64**:228 (Dec.) 1927.

Evidence that the vagus nerve may play a part in the control of the blood sugar level has been brought forward by many investigators, the majority of whom have suggested that this nerve, on stimulation, produces a secretion of insulin. Taken as a whole, the available evidence is strongly presumptive that the vagus contains secretory fibers to the islets of Langerhans. The vagus may also have atonic inhibitory action, since for some weeks after section of the nerve in rabbits, the sugar tolerance is not diminished but increased.

Clark states the hypothesis that the normal mean level of sugar concentration in the blood is maintained in part by tonic inhibition of the islets, more pronounced when the blood sugar is low, itself inhibited when this is raised. In his experiments on vagotomy, therefore, he made his preparations so that (1) the sugar in the blood was not above the mean level, and also (2) the chance of intervention of the liver was diminished as far as possible. In the first series, using cats under amytal anesthesia, in all but two cases, section of the right vagus in the neck was followed by a definite fall in blood sugar. In both the exceptions the initial sugar level was high above the normal level. To rule out the suggestion that the nerve was stimulated in the act of cutting, the nerve was frozen in one experiment and in another the part distal to the cut was blocked by a constant current. There was no change in results.

In an attempt to localize the organ on which the vagus acts, the right nerve was cut as it entered the abdominal cavity on the posterior aspect of the esophagus. Here again, vagus section was followed by a fall in blood sugar, thus ruling out the idea of interference with pulmonary or cardiac function as the causative factor. The suprarenals were tied off and all nervous connections to the liver severed, and the results were similar to those in the first series.

Attempts to rule out the duodenum were unsuccessful, but at the present time it is not known that that or any other part of the alimenary canal influences the sugar content of the blood in any way other than passively during absorption. It seems, therefore, that the pancreas is the organ acted on. Section of the right vagus above or below the diaphragm in cats under amytal anesthesia produces an immediate fall in blood sugar, the degree of which varies with (a) the initial blood sugar level and (b) the glycogen reserve. Clark suggests that the effect is produced by cutting off tonic inhibitory impulses which control insulin secretion.

ALPERS, Philadelphia.

EPILEPSY AND SCHIZOPHRENIA. EDUARD KRAPF, Arch. f. Psychiat. **83**:547 (April) 1928.

The question whether true epileptiform attacks occur in schizophrenia served as the basis of the study and the results are reported. A large number of cases of schizophrenia (1,506 cases admitted to the hospital in Munich during the years from 1923 to 1926 inclusive) and epilepsy were studied, and the following points were investigated: Do epileptiform attacks occur in the course of the schizophrenic process? Do combinations of schizophrenia and genuine epilepsy occur? Does one meet with schizophrenic episodes in the course of a genuine epilepsy? The author comes to the following conclusions: In the material studied, as well as in the numerous reports in the literature, there are no definitely established cases in which true epileptiform attacks occur in the course of the schizophrenic process, except a few rare instances in which the attacks occurred just before death and in which edema of the brain was found post mortem. Similarly, there were no cases in which a combination of the two processes could be proved beyond doubt; although theoretically such combinations are not impossible, they must be rare. Theoretically, too, it is possible that on rare occasions epileptic-like attacks may occur in the course of a schizophrenic process, but they would have to be regarded more as an effect of the etiologic factors which cause schizophrenia rather than as a symptom of the disease. It is possible that the edema of the brain mentioned may not end fatally and yet may produce epileptiform attacks. The author himself has never observed such an occurrence. A detailed study of postepileptic states, however, shows that clinical syndromes simulating closely those encountered during the course of a schizophrenic process may occur during these states, and may even last for a period of several months. In some of these cases it is possible to trace a tendency to schizophrenic reactions in the family history of the patient. Paranoid-like syndromes of this type are especially frequent in epilepsy occurring in advanced age. The differential diagnosis is rather difficult both when an epilepsy-like attack occurs in a schizophrenic patient and when schizophrenia-like states occur in an epileptic patient. In such cases the consciousness of the

patient should receive particular attention. The occurrence of clouding of consciousness would speak for epilepsy as the most probable diagnosis. The retardation, monotony and similarity of content should also be taken as proofs for epilepsy.

MALAMUD, Foxborough, Mass.

THE ONTOGENY OF THE CORTEX OF THE INSULA (CONTRIBUTION TO THE HISTOGENETIC DIVISION OF THE CORTEX). MAXIMILIAN ROSE, J. f. Psychol. u. Neurol. **36**:182, 1928.

Embryologically, two large groups of cerebral cortexes are distinguished: (1) cortex totoparietinus, and (2) cortex semiparietinus. The former has its own layer of matrix and is developed from the entire cross-section of the wall of the secondary cerebral vesicle (pallium); Rose therefore designates this cortex as cortex totoparietinus sive pallialis. Very early in its development this cortex consists of two portions; in one of these the cortical plate (protoptyx) exists as a single layer of cells (cortex totoparietinus holoprotoptychos); in the other the same plate appears as a double layer of cells (cortex totoparietinus schizoprotoptychos). The cortex semiparietinus is developed on the surface of the striatum from the same layer of matrix as the striatum itself, hence the designation cortex semiparietinus sive striatalis.

The cortex of the insula assumes histogenetically an intermediate position between the cortex totoparietinus sive pallialis and the cortex semiparietinus sive striatalis, because its cellular elements are derived from the layer of the matrix of the pallium as well as from that of the striatum. Rose therefore proposes for it the designation "cortex pallio-striatalis" or "cortex bigenitus." Depending on the number of its cellular layers, the cortex pallio-striatalis is subdivided into cortex quattuor, septem, and novem stratificatus.

Histogenetically, the author divides the cortex of the insula as follows: (1) Cortex semiparietinus sive striatalis (regio prepyriformis, tuberculum olfactorius, regio periamygdalaris, regio diagonalis, septum pellucidum). (2) Cortex totoparietinus sive pallialis: (*A*) schizoprotoptychos: (*a*) parumstratificatus (regio presubicularis, area perirhinalis), (*b*) multistratificatus (regio entorhinalis); (*B*) holoprotoptychos: (*a*) bistratificatus (cornu Ammonis, subiculum, taenia tecta, fascia dentata, regio retrobulbaris); (*b*) quinquestratificatus (regio infraradiata regio subgenualis, regio retrosplenialis granularis, regio retrosplenialis agranularis); (*c*) septemstratificatus (regio frontalis, regio parietalis, regio temporalis, regio occipitalis). (3) Cortex palliostriatalis sive bigenitus: (*a*) quatuorstratificatus (area prepyriformis 1); (*b*) septem (octo) stratificatus (regio insularis agranularis); (*c*) novemstratificatus (regio insularis granularis and propeagranularis).

KESCHNER, New York.

LOW BACK PAIN. JOHN T. O'FARRALL, J. A. M. A. **91**:8 (Aug. 25) 1928.

Attention is called to the rôle played by the soft parts in the causation of pain in the lower part of the back as well as to the relationship of the various bony structures to one another and to the attached soft parts. Too much stress has been laid in the past on bony abnormalities of the lower part of the spine. The lumbosacral joint is an unstable articulation. Reasons for this are presented by the author. Momentary relaxation of the muscles, such as occurs on an impending effort, passes the burden of stability entirely into the ligaments which are long, slender and inelastic. The chief nerve structure to be found in this vicinity is the lumbosacral cord made up from branches of the fourth and fifth lumbar roots — the so-called sciatic distribution. It passes under the fifth lumbar transverse process and is in intimate contact with the ligaments mentioned. Bony abnormalities are a contributing cause, but the real pathologic condition lies in the ligamentous and neurologic soft parts.

The lumbosacral joint is a pivotal joint on which devolves the great part of the motion of the trunk on the pelvis. In the erect position, body posture is maintained by the muscles and articular processes, but in the position of forward

bending stability of the joint depends on the ligaments and muscles. If the muscles relax, as in lifting or pulling, the entire burden falls on the ligaments. The result is a real ligamentous strain with acute stabbing pain, acute swelling, hemorrhage and edema. Untreated or improperly treated these cases often become chronic.

An active intercurrent infection is usually found on careful search and elimination of a focus or foci of infection or toxemia is at once indicated. X-ray examination usually fails to reveal any pathologic condition of the bone.

As treatment the author recommends (when there is muscle spasm) rest at 45 degrees of straight leg raising with extension. Fixation of the lumbosacral joint is then carried out. In prolonged, obstinate cases, epidural injection of saline and procaine hydrochloride into the sacrococcygeal foramen is recommended.

O'Farrell concludes: (1) that the majority of the acute and many of the chronic backaches occur in young adults, under 45, as a result of sprain of the lumbosacral ligaments; (2) that the strain generally occurs in males engaged in laborious work, athletes and others in awkward posture.

CHAMBERS, Syracuse, N. Y.

RESPIRATORY METABOLISM CHANGES IN SCHIZOPHRENIC PATIENTS. (SECOND COMMUNICATION: THE CHANGES DURING THE COURSE OF THE DISEASE AND THEIR SIGNIFICANCE FOR THE INVESTIGATION OF THE ETIOLOGY.) S. FISCHER, Arch. f. Psychiat. **83**:205 (March) 1928.

In a previous communication (*Klin. Wchnschr.* **6**:1987, 1927), Fischer reported definite changes in basal metabolism in cases of schizophrenia as compared with normal conditions in manic-depressive psychoses. In the present article, the author discusses the relation of these changes to the different stages during the course of the schizophrenic process. Determinations were made of the basal metabolism as well as of the specific dynamic protein action. (For determination of the latter a breakfast consisting of 200 Gm. of minced meat, 100 Gm. of bread, 50 Gm. of butter and a cup of black coffee. The basal metabolic rate was measured from one to one and one-half hours after the breakfast.) The results are summed up as follows:

In incipient schizophrenia a decrease of the specific dynamic action is found with a lowering of the basal metabolism following it. The specific dynamic action may rise afterward, but the basal metabolism remains low throughout the duration of the disease. With the cessation of the acute symptoms, the metabolic disturbances remain for a while, and then show a tendency to return to the normal. With the occurrence of a new attack, a repetition of the changes takes place. In cases in which the condition improved after the acute attack, but left some defect, the basal metabolism continued low, and at times there was also a lowering of the specific dynamic action. In some cases, the low basal metabolism found after the acute attack is over is accompanied by a pronounced tendency to obesity and decreased sexual libido. The lowering of the basal metabolism comes on from a few weeks to two months after the onset of the psychosis, and a rise in the basal metabolism during the psychosis should be looked on as a good prognostic indication, whereas lowering of the basal metabolism is an indicator of a poor prognosis. The author is of the opinion that the cause of these metabolic changes (which may be connected with the cause of the psychosis) is not to be looked for in the thyroid nor in the gonads, but is probably related to changes in the pituitary gland.

MALAMUD, Foxborough, Mass.

ADAPTATION OF THE FAMILY TO THE CHILD. SANDOR FERENCZI, Brit. J. M. Psychol. **8**:1, 1928.

Psychoanalytic studies have all tended to show the importance of child life, and there is great need of gaining a better understanding of the real difficulties that confront the child. Parents must conceive their job as adapting themselves to the child rather than expecting the child to adjust to them. The first situation

faced by the child is birth. One school ascribes the mental disturbance of later life to this "trauma." Compared to later situations, however, there are none for which the child is better prepared. It is a triumph for the child, and everything is done to protect it from harm. The real traumas are those which concern the child's entry into association with his fellow beings, such as the traumas of weaning, cleanliness, the breaking of bad habits and the breaking from childhood itself into the adult way of living.

The character of the child is influenced by the way that parents seek to bring about habits of cleanliness in accordance with an adult code. Freud has put this factor in the foreground by declaring that "the way the individual adapts his primitive urges to the requirements of civilization in the first five years will determine the way in which he will deal with all his difficulties later in life." Cleanliness is a trait that has to be developed — it certainly is not inborn — and a child at first, having a love of himself and all that forms a part of himself, resists the efforts to get him to give up an interest which he has for his dejecta.

Sexuality is the second great trauma in the adaptation of the family to the child. It begins, not at puberty, but with the erroneously termed "bad habits" of childhood — which are taken too seriously by parents. Sex education by botanic method is too informative and not directed to satisfying the internal needs and strivings of the child. "What the child really needs is an admission of the erotic importance of the genital organs." Other conceptions fall short and create a gulf between parent and child because the parents, by their attitude, deny the existence of feelings which the child is experiencing. The parent becomes an unattainable ideal in the eyes of the child who is experiencing things which he feels do not exist in parents and which therefore make him an inferior person.

ALLEN, Philadelphia.

SURGICAL RELIEF OF PAIN IN EXTENSIVE MALIGNANT DISEASE. WITH ESPECIAL REFERENCE TO SECTION OF THE SENSORY BRANCHES OF THE VAGUS FOR DEEP PAIN IN THE EAR. TEMPLE FAY, J. A. M. A. **91**:6 (Aug. 11) 1928.

Metastasis of primary carcinoma of the lip, tongue and upper part of the pharynx to the submaxillary and superior deep cervical lymph nodes causes a characteristic and severe pain which requires opiates in increasing doses for relief. A sensory study of the areas involved was made, and a method of sectioning the nerve pathways involved was devised. Attention is caused to the overlap existing between the mandibular branch of the trigeminus and branches of the cervical plexus. Mention is made and brief description given of rhizotomy, section of the posterior root of the trigeminus, as suggested by Spiller, and the operation of chordotomy of Spiller. Rhizotomy is the method of choice in lesions involving the shoulder, upper extremity and cervical areas.

In cases in which the trigeminus, glossopharyngeus and posterior cervical roots had been destroyed for relief from pain, a deep pain in the ear remained. This intractable pain was thought to be due to the involvement of the auricularis vagi nerve, and in the next case a subtotal avulsion of the trigeminus was done as well as an intracranial section of the roots of the vagus. Pain was relieved completely, but there occurred great difficulty in swallowing, paralysis of the pharynx and a unilateral paralysis of the vocal cord.

With the origin of this deep pain in the ear established as due to involvement of the sensory branches of the vagus, an extracranial approach was devised so as to section the sensory filaments but leave the root or fibers undisturbed. This method is described in some detail along with a statement of the relief obtained and complications that have ensued. Sensory charts are presented as well as pictures illustrating technic. There is a table giving the age, the lesion and its location, the distribution of pain, the operative results and the duration of life in sixteen cases. Fay concludes that surgical relief from pain due to extensive malignant disease of the face and neck offers the patient real relief, which justifies the comparatively slight additional operative risk.

CHAMBERS, Syracuse, N. Y.

ANALYTICAL TREATMENT OF A NEUROTIC REACTION. A STUDY IN SYMBOLISM. LELAND E. HINSIE, Psychiat. Quart. **1**:5 (Jan.) 1927.

Hinsie states that the therapeutic efficacy of psychoanalysis is dependent to a large degree on the amount of dissociation between affect and ideational content. Possibly large gaps between the two may be closed in and a coordinate functioning reestablished by gaining a more adequate emotional response from the thought content. The problem has been to reduce the symbolizations to their real meanings and then to cause a fusion of the latter with their proper affective values.

The schizophrenic group has been a particularly difficult one in which to effect such a reconciliation, probably because of a lack of altruistic transference and a spontaneous wish for insight. The borderland group in which the patients are largely psychoneurotic but at the same time show unmistakable evidences of splitting are more amenable. A study of these persons may lead to a more comprehensible understanding of the factors tending to induce "lack of insight."

A case history is given of a young man, a college graduate, with an intelligence quotient of 120. From early childhood he had been troubled with the fear of death, at times so great as to give rise to anxiety states. From this grew an attachment to physicians that later developed into a fetish worship and a host of symbolizations. The basis of the fear was a mother fixation; the scope of the mechanism finally included most of the household. Associated with this were homosexual and auto-erotic manifestations. His illness rendered him entirely economically dependent on the family, and at the same time unable to live at home. At the age of 17 he was sent to a hospital. Here he steadfastly resisted and resented efforts to remove the cause of his illness, and the neurosis became intensified. Efforts to bring about the proper association between the emotional and intellectual processes failed. After several years of treatment the improvement that occurred was due to the fact that the intellectual sphere was somewhat flexible and slightly offset the rigid emotional one. Further improvement will be limited by the degree that the two can function separately.

HOWARD, Milwaukee.

A CONTRIBUTION TO THE PROBLEM OF HYPERVENTILATION. C. KOLL, Arch. f. Psychiat. **83**:597 (April) 1928.

Within recent years, hyperventilation has been introduced as a diagnostic procedure in suspected epilepsy. This method was studied particularly by Foerster, in Germany, and by Rosett in this country. Foerster found that in 55.5 per cent of epileptic patients he was able to demonstrate epileptic attacks by hyperventilation, and in all cases other irritability phenomena, such as spontaneous Trousseau tremors and clonic or clonic and tonic convulsions of single muscle groups. These observations, however, could not be completely substantiated by other students of the subject. The author studied fifty cases with the following results: in eleven cases of genuine epilepsy epileptic seizures were not demonstrated by hyperventilation; instead of these, absences were demonstrated in two cases. In sixteen cases of symptomatic epilepsy, a true epileptic seizure was demonstrated in only one. In twelve cases of questionable epilepsy, there was an epileptic seizure in one, a "psychogenic" attack in another, and an absence in a third. In seven cases of hysterical seizures, three "psychogenic" attacks were observed. In one case of hydrocephalus internus, in two cases of tumor of the brain, and in one of encephalitis, the procedure was without results.

The examinations were performed with the patient either sitting (Foerster) or lying (Rosett). The patient was asked to breathe deeply, synchronously with the beats of a metronome. This was continued for from twenty to twenty-five minutes. In those cases in which hyperventilation brought forth any result, it occurred in from seven to twelve minutes after the beginning of the experiment. The author comes to the conclusion that although this procedure may be of some help in differential diagnosis, it certainly is not an infallible criterion.

MALAMUD, Foxborough, Mass.

TYPHOID MENINGITIS IN A TWO MONTHS OLD BABY. PANOS S. DUKAKIS, J. A. M. A. **89**:2257 (Dec. 31) 1927.

Meningitis is rarely observed as a complication of typhoid fever, perhaps owing to the fact that it has been overlooked. A case occurring in a baby, aged 2 months, is reported. The chief complaint was regurgitation. Physical examination on admission to the hospital gave negative results. The temperature was 101.5 F.; the blood contained 4,000 leukocytes per cubic millimeter. Changes were not noted from physical examinations during the next three days, but the fever was sustained, and the leukocyte counts were 7,000 and 8,000. On the fourth day, the child was ill, the anterior fontanel was bulging and a slightly rigid neck and nystagmus were noted. All reflexes were active. A Babinski sign was reported as being suggestive, but this sign should be positive at this age. Neither a Brudzinski nor a Chvostek sign was present.

Lumbar puncture yielded 5 cc. of opalescent fluid which was not under increased pressure. A cisternal puncture made at the same time yielded cloudy fluid under a pressure of 30 mm. of mercury. Antimeningococcus serum was given by both the lumbar and the cisternal needle. The fluid yielded a luxuriant culture of gram-negative bacilli which corresponded with the typhoid organism and were agglutinated by typhoid antiserum in a dilution of 1:12,800. A Widal test was positive with the blood in a dilution of 1:100 and with the spinal fluid in a dilution of 1:10. A culture of the blood was sterile. Cultures of the urine and spinal fluid yielded typhoid bacilli. Death occurred on the fifteenth day. Gastro-intestinal symptoms were not elicited. An autopsy was not obtained. The source of the infection was traced to the home where carriers were found.

CHAMBERS, Syracuse, N. Y.

ASYMPTOMATIC NEUROSYPHILIS: A COMPARISON OF EARLY AND LATE ASYMPTOMATIC NEUROSYPHILIS. JOSEPH EARLE MOORE and MILDRED FAUPEL, Arch. Dermat. & Syph. **18**:99 (July) 1928.

The authors report a fairly large series of cases in which there were not any or only minor neurologic symptoms. The series includes both patients with early syphilis and those with late syphilis, and is divided into three groups on the basis of observations on the spinal fluid: (1) patients with slight serologic changes; (2) those with moderate serologic changes; (3) those with marked serologic changes (the paretic type). Some spinal fluids with serologic changes were found even among the cases of primary syphilis. More than twice as many spinal fluids with serologic changes (23.4 per cent) were found in cases with a positive Wassermann reaction of the blood than in those with a negative reaction.

The incidence of abnormalities in the spinal fluid was markedly reduced in all cases in which adequate treatment had been given. In early syphilis the changes were equal in men and women, but they were less frequent in negroes; in late syphilis women seemed to be less affected than men. Asymptomatic neurosyphilis was three times as frequent in early cases in which treatment was intermittent as in those cases in which the therapy was administered without rest periods. This was not true of late syphilis. The authors believe that a persistently positive Wassermann reaction of the blood in early cases is indicative of asymptomatic neurosphyhilis, but that this indication does not hold true in late cases. Minor objective and subjective symptoms in early syphilis have essentially the same indication as a persistently positive Wassermann reaction of the blood.

WAGGONER, Philadelphia.

BARBITAL AND RELATED HYPNOTICS. EDITORIAL, J. A. M. A. **91**:398 (Aug. 11) 1928.

Many substitutes have been introduced for barbital, U. S. P., with claims of greater relative hypnotic action as compared with toxic effects. The activity of barbituric acid derivatives depends largely on the character of the combined radical, but relative toxicity depends partly on certain physical factors which determine

the relative amount taken up by the central nervous system. The toxic action is only an intensification of the depression of the central nervous system which in therapeutic doses produces nearly normal sleep.

Eddy gave equal fractions of the fatal dose of various hypnotics to cats and compared the effects with reference to posture, sleep, heart rate, respiratory rate, analgesia, rectal temperature, conjunctival reflex, knee reflex and other conditions. None were much more actively hypnotic than barbital in proportion to toxicity, while there were indications to point that none are relatively less toxic. None of the five hypnotics examined exerted marked analgesic effects with less than 30 per cent of the fatal dose.

Some of the minor details are then reported. In none was there any important uniform action on the heart rate, even with the largest doses, so that probably the normal human heart is not injured by therapeutic doses of any of them. One gains the impression that none of the substitutes possess all of the advantages and none of the disadvantages of the official barbital.

CHAMBERS, Syracuse, N. Y.

THE BIOLOGY OF FEEBLEMINDEDNESS. GEORGE VAN NESS DEARBORN, J. Nerv. & Ment. Dis. **68**:250 (Sept.) 1928.

Feeblemindedness appears to be due to a defect in the upper layer of the cerebral cortex or neopallium. The latter appeared originally to be a center for muscle coordination; originally, the cerebrum of man has been evolved through the development of complex muscle coordination, together with afferent kinesthetic and cenesthetic impulses arising from the muscles. According to this concept, the source of all consciousness may be attributed to the muscles.

From a study of the origin of language, the author concludes that words, hieroglyphics and pictographs are but symbols of neuromusculoglandular movements. The roots of all fundamental words denote action; for example, the word "cave" means originally, in all languages, a hollowing out movement with the hands. Thought is repressed, inhibited speech, as shown by the electrical study of the vocal muscles during deep thinking. In the same sense, music may be regarded as repressed dancing. Words, then, denoting motor experience are, hypothetically, the source of energy with which the permanent associations and correlations are recorded in the cortex. Bolton and Campbell considered the cortex of the human being as an organ of five layers of which the supragranular layer was the most important in the evolution of intelligence. It is this layer that is probably affected in feeblemindedness. These facts are intended apparently to emphasize the psychomotor deficiency in feeblemindedness.

HART, Greenwich, Conn.

THE SEAT OF THE EMOTIONS. EDITORIAL, J. A. M. A. **91**:568 (Aug. 25) 1928.

A recent writer has interpreted the mind as an expression of brain activity just as digestion is the function of the alimentary tract. Normal cerebral activity is the process underlying the mind or intelligence and mental disturbances are psychic and behavioristic aspects and expressions of abnormal cerebral function. The endeavor to locate the seat of psychic processes in definite parts of the nervous system becomes then a logical procedure. Thought, memory, imagination and volition have been referred to the cerebral hemispheres.

The emotions are not merely reflected in consciousness but also lead to various physiologic phenomena. Is the seat of the emotions cortical or not? Bard has already commented that the bodily changes making up emotional behavior are not necessarily due to a nervous discharge of cortical origin. Certain mammals deprived of their cerebral hemispheres show symptoms resembling anger and rage on appropriate stimulation. Emotions produce not only obvious changes of posture and expression but also marked visceral changes.

Bard, working in the physiology laboratories of Harvard Medical School, attempted to locate the central source of characteristic sympathetic discharges.

Ablation of varying portions of the brain stem of the decorticate cat was the method used. Sham rage failed to appear after sections separating the ventral and most caudal fractions of the lower half of the diencephalon from the midbrain. This leads to the conclusion that the expression of anger in the cat is here located.

CHAMBERS, Syracuse, N. Y.

A CRITICAL DISCUSSION OF THE CONSTITUTIONAL ANOMALIES OF EPILEPTICS. L. PIERCE CLARK, Psychiat. Quart. **1**:26 (Jan.) 1927.

Before beginning the anthropologic critique the author asserts that the epileptic constitution is not brought about as a result of the seizures but that the essential characteristics are present before the onset of the seizures. The salient characteristics of the epileptic make-up are egocentricity, supersensitiveness and emotional poverty. These he calls epileptic narcissism; they are the result of previous or continued castrations or traumas, originating from birth, breast or bottle weaning and especially from withdrawal of diapers. The fit with loss of consciousness is an effort to recover former rapport with the world experienced in intra-uterine life and escape a world invested with pain and displeasure; by this the epileptic gains fantasial recall of the desired period.

The author believes that he has succeeded in reducing the epileptic state by repeated analysis in which the fantasial phase was repressed or transformed into object libido, thereby reducing the dynamic drive of the libido energy which remained attached to the ego. There then follows a comprehensive review of the literature to determine whether or not there is a specific epileptic physical substrate. His observations show that a constant physical substrate for the epileptic constitution does not exist. No alterations are found that are not found in an equal number of other persons who are biologically inferior for other reasons.

HOWARD, Milwaukee.

THE HISTOPATHOLOGIC CHANGES IN THE EIGHTH NERVE AND ITS NUCLEI IN TYPHUS. N. F. POPOFF, Arch. f. Psychiat. **83**:264 (March) 1928.

The frequent occurrence of complications of the eighth nerve in the course of typhus led Popoff to investigate, by postmortem examinations, the exact anatomic changes in eleven cases. He comes to the following conclusions: The eighth nerve is practically always involved in the course of typhus fever. Involvement may be of different degrees, and the prognosis depends on the severity of the disease. The frequency and degree of intensity of the involvement of the cochlear and vestibular branches are about equal. The histologic changes are the same as have been found in other tissues: At first there is a destructive thrombo-vasculitis with dilatation of the vessels, stasis, hemorrhages and thrombi. This is followed by infiltration into the vessel wall and around it, and at times there is a formation of typical typhus nodules. The fibers of the eighth nerve undergo periaxial neuritic changes (Gombault-Stransky), or typical descending wallerian degeneration.

The author believes that the vulnerability of the eighth nerve in typhus is probably due to the rich vascularization of this nerve by the arteria auditiva. He is of the opinion that the process should be regarded as a parenchymatous typhus neuritis caused by the characteristic nodules or by the pathologic changes which accompany them.

MALAMUD, Foxborough, Mass.

EMOTIONAL LEUKOCYTOSIS. CURRENT COMMENT, J. A. M. A. **91**:649 (Sept. 1) 1928.

Only comparatively recently has any attempt been made to formulate a "physiology of the emotions." That bodily functions are unmistakably affected by emotional stress has long been recognized. Blushing and pallor noted in everyday life need not be produced by physical stimuli, showing that the circulation definitely responds to changes in the mental state. Increase in pulse rate

is only one indication of physiologic change due to excitement. Incidents in life, as well as external heat, may produce beads of perspiration. The work of Cannon is mentioned. Recently, Izquierdo and Cannon reported that emotional excitement for relatively brief periods is quickly followed by a pronounced rise in red blood corpuscles. Now Menkin has announced that emotional stimulation of a normal animal leads to a relative mononucleosis which lasts a brief period. This phenomenon fails to appear if the animal has been sympathectomized or if the spleen has been disturbed in its function. Menkin believes that as a result of emotional or other sympathetic activation splenic contractions force increased erythrocytes and mononuclear cells out into the general circulation. The rapid disappearance of the leukocytes after emotional excitement may be explained in that lymphocytes may leave not only the blood stream but also the body.

CHAMBERS, Syracuse, N. Y.

A Suggestion of the Therapeutic Value of Glucose Based on Investigation of Carbohydrate Metabolism of the Feebleminded. A. N. BRONFENBRENNER, Psychiat. Quart. **1**:85 (Jan.) 1927.

The author comments on his observation that the resistance of mental defectives to infections is lower than that of normal persons; also that minor injuries apparently without complications do not heal as readily as they usually do in normal persons. It is shown that there are changes in the metabolic mechanism of mental defectives, particularly that a higher proportion of carbohydrates is demanded than in normal persons. The inference then is that when the defective metabolism is called on to take care of the increased disintegration of body cells, the product of disintegration will be harbored in the tissues instead of being properly metabolized. The administration of dextrose, which increased the dextrose circulating within the metabolic channels, would be of therapeutic value as it raises metabolic efficiency.

Two cases are cited of mental defectives with inflammatory processes, probably of traumatic origin, in which the patients responded only slowly to usual surgical procedures. Healing in both instances advanced only to a certain stage and resisted all further treatment. Following the administration of dextrose the lesions responded immediately and healed normally.

HOWARD, Milwaukee.

Report of Case of Myasthenia Gravis with Visceral Symptoms: Clinical Contrast with a Case of Dystonia Musculorum Deformans. ARTHUR N. FOXE, J. Nerv. & Ment. Dis. **68**:134 (Aug.) 1928.

Myasthenia gravis is contrasted with dystonia musculorum deformans, as exhibited respectively in two women, aged 23 and 25 years. The symptoms of the patient with myasthenia gravis were: marked fatigability of almost all the skeletal muscles, diplopia after reading, palpitation of the heart on slight exertion, marked constipation due to atony of the intestinal musculature, weakness of the sphincters causing frequent incontinence and afternoon fatigue and apathy. The patient showed bilateral ptosis, bilateral weakness of the external rectus and nystagmus, with little volitional or spontaneous movement of the facial musculature. In contrast to the fatigability in the case of myasthenia gravis, the case of dystonia musculorum deformans showed constant movement and absence of fatigue. In the latter, there is hypertonia instead of hypotonia, constipation due to spasm instead of atony, vesical tenesmus in place of relaxation, and an excitable psychic state as compared with psychic apathy. Both diseases are gradual in onset and are characterized by exacerbations and remissions in their course. They do not exhibit any involvement of the pyramidal tract. The author discusses the similarity of the two conditions in the hope that some etiologic connection may be discovered.

HART, Greenwich, Conn.

CISTERNAL AND LUMBAR PUNCTURE: A COMPARATIVE STUDY OF THE FLUIDS IN SYPHILIS. HARRY C. SAUNDERS and LEO SPIEGEL, J. A. M. A. **91**:630 (Sept. 1) 1928.

Cisternal puncture has been shown by numerous observers to possess a distinct advantage over lumbar puncture and to be the method of choice for routine test when the technic is acquired. Biologic reactions are at times more intense in the lumbar than in the cisternal fluid. One observer considers that this is due to the freer circulation of fluid in the cisternal cavities and also to sedimentation, but others dispute this theory.

A study of forty-three cases was made by the authors. Their results are reported in detail by means of statistics and tables as to globulin, colloidal gold precipitation, cell count and Wassermann tests. They concluded that: (1) there were only slight differences in cell count, globulin and colloidal gold; (2) there was practically no difference in the Wassermann test; (3) the interpretation of an analysis of the spinal fluid must not be based on a single observation but on the results of all four tests in conjunction with the clinical examination; (4) because of the slight differences existing at times in the two fluids the distinct advantages to the patient following cisternal puncture should lead the observer to prefer cisternal to lumbar puncture.

CHAMBERS, Syracuse, N. Y.

DEGENERATION PSYCHOSES. E. RUDIN, Arch. f. Psychiat. u. Nervenk. **83**:376 (March) 1928.

This article represents a "Korreferat" read by the author at a meeting of the Swiss Psychiatric Association in conjunction with Binswanger's paper on the same subject. Rudin starts out with the statement that whatever concept may be considered by the adherents of the existence of this entity, the name "degeneration psychoses" is poorly chosen. It cannot apply to all psychoses that are either wholly or partially due to factors transmitted by heredity. It could only be applied rightfully to such mental diseases that are due to mutations. In such psychoses it is still to be proved where and how the mutation has occurred, and how this was responsible for the occurrence of the psychosis. Neither present knowledge of heredity in general nor its relation to definitely established psychotic entities permit one as yet to talk of psychoses that are primarily conditioned by hereditary factors. He is quite certain that constitutional factors play a great rôle in the development of psychoses. A point, however, has not yet been reached at which one can base any classifications on knowledge in this field. Even clinically it is not possible to recognize degeneration psychoses as such because in a great many instances disturbances classified under this group were afterward found to belong to some other previously established type of mental disorder.

MALAMUD, Foxborough, Mass.

Society Transactions

BOSTON SOCIETY OF PSYCHIATRY AND NEUROLOGY

Regular Meeting, Oct. 18, 1928

H. C. Solomon, M.D., *President, in the Chair*

A Case of Tuberculous Meningitis with a Practically Normal Spinal Fluid. Dr. James W. Watts.

The case here reported is one of tuberculous meningitis, proved by inoculation into a guinea-pig, in which the first lumbar puncture yielded spinal fluid with a normal pressure and cell count at a time when the temperature was normal. This was followed in a few days by the usual serologic observations.

History.—The patient, a white man, aged 24, was admitted to the Massachusetts General Hospital on July 7, 1928, complaining of headache and vomiting. The family history as given by the patient was negative for tuberculosis. Later, it was learned from a relative that the father, mother, sister and an uncle died of tuberculosis when the patient was a young child. The present illness started two weeks before admission with a generalized but not severe headache. Ten days later, he became dizzy suddenly and vomited immediately. The headache became constant and more severe, and the vomiting continued at the rate of four or five times a day.

Examination.—Physical examination gave essentially negative results; no abnormal breath sounds or râles were noted in the lungs. The blood pressure was 110 systolic and 60 diastolic; temperature was 98.8 F.; the pulse rate was 50, and the respiratory rate, 20. Neurologically, the patient was intelligent and clear mentally, without aphasia or apraxia. He did not recognize odors with the left nostril. The margins of the right optic disk were blurred and the vessels engorged, but papilledema was not present. The left fundus was normal. The other cranial nerves were normal. Coordination was good and there were no sensory disturbances. The tendon reflexes were equal; the abdominal reflexes, absent; plantar stimulation caused flexion on the right and no response on the left. There was neither stiffness of the neck, nor Kernig or Babinski signs. Urinalysis gave negative results and roentgenograms of the skull were normal.

Course.—On July 7, the day of admission, a lumbar puncture showed an initial pressure of 150 mm. of water; cell count, 4, all lymphocytes; total protein, 83 mg.; Wassermann reaction, negative; colloidal gold curve, 0112100000. The temperature remained normal for six days, and the pulse rate ranged between 45 and 70. A diagnosis of brain tumor was thought of, but there was insufficient evidence to prove it. The patient was about to be discharged from the hospital when, on July, 11, he developed aphasia for certain words. The next day he became irrational. On July 13, lumbar puncture yielded spinal fluid with an initial pressure of 250 mm. of water; cell count, 205, all lymphocytes; total protein, 85 mg. The temperature rose to 101.8 F. Later examinations of the spinal fluid gave similar results, with low sugar content and chlorides. The temperature and pulse rate became irregular and the clinical course became that of tuberculous meningitis, with death on July 22.

Comment.—In reviewing the literature from 1916 to 1928, I have not found any case reported like this one. The cell counts vary considerably and some few have been normal, but they are unaccompanied by the other observations. In a series reported by Stuart, they range from 20 to 1,000, averaging from 100 to 300; by Condat from 47 to 400; in Kinnears they average 73; Fonticella and Supulveda reported counts from 8 to 1,000. Bickle found the average count to be 230 cells with a minimum of 0 and a maximum of 1,400, but he did not state the number

of normal counts. In the series on the cerebrospinal fluid of man the average count was 112, with a minimum of 0 and a maximum of 1,000. Five of the fluids had normal counts. McClelland found cell counts ranging from 3 to 1,870, with an average of from 100 to 400, but he did not state the number of normal counts. Reux reported three cases with from 5 to 6 cells per cubic millimeter.

DISCUSSION

DR. HENRY R. VIETS: The interesting thing about this case is that the patient entered the hospital so early that we saw the effect of tuberculous meningitis before the meningitis had developed enough to give a cell count in the spinal fluid.

DR. H. C. SOLOMON: The dramatic situation was not emphasized by Dr. Watts. The man came to the hospital as it was suspected that he had a tumor. He had severe headache, nausea, vomiting and occasional confused spells. When he entered the hospital there was no fluctuation in temperature, nothing suggesting meningitis, no Kernig sign and an examination of the spinal fluid which, looked at roughly, might appear normal. The total protein was high; the gold curve showed nothing suggestive. It was not the routine to make quantitative estimations of chlorides or sugar. He seemed perfectly well during the first four or five days he was in the hospital. Nothing suggestive of a tumor was found. Then he suddenly became aphasic, which saved us the embarrassment of having him go out of the hospital without a diagnosis. Whether the meningitis was precipitated by the lumbar puncture or whether it was the normal course of the disease is not clear. It is possible that he had a solitary tubercle and that this was followed by meningitis.

DR. FRANK FREMONT-SMITH: Do you know whether the tuberculous meningitis was part of a generalized miliary tuberculosis or whether it came from a solitary tubercle in the brain? I have seen a puncture in one case very early in the disease when the initial pressure was normal; a few days later it was definitely elevated. In a patient who we suspected had increased pressure but in whom the pressure was found to be normal, we learned that about six hours before puncture the patient had been given a dose of magnesium sulphate. The same thing happened on two other occasions in which the pressure should have been high and turned out to be low. It would be interesting to know whether there had been any medication previous to this first puncture.

DR. WATTS: I cannot recall whether the patient had received any medication, but I feel sure that he did not have magnesium sulphate as other cathartics are used more frequently in the hospital. His chest was examined at frequent intervals without abnormal observations, but roentgenograms were not taken. As there was no postmortem examination, I do not know whether or not he had miliary tuberculosis.

THREE CASES OF ASEPTIC (LYMPHOCYTIC) MENINGITIS. DR. HENRY R. VIETS and DR. JAMES W. WATTS.

Three cases of aseptic meningitis occurring during the month of August, 1928, are reported. These patients were seen on the neurologic ward at the Massachusetts General Hospital. They all entered the hospital with a complaint of severe headache and vomiting, showed a course of subacute nature with moderate fever, and all recovered. Clinically, they were characterized by the symptoms of a mild meningitis and by the presence of lymphocytes in the spinal fluid without polymorphonuclear cells or organisms.

CASE 1.—J. L. G., aged 23, single, entered the hospital on July 30, 1928, with a complaint of severe frontal headache and chilliness. The patient had worked on the morning of the day he entered the hospital. His symptoms had begun in June, at which time he had an attack of unconsciousness while at work and was taken to a hospital. He quickly recovered. About two weeks before he was admitted he began to have severe frontal headaches.

When he was admitted to the hospital he was irrational and noisy. He responded quickly to drainage of the spinal fluid, which was repeated seventeen times in the course of twenty-seven days. The temperature, which ranged between 97 and 101 F., became normal at the end of two weeks. The headache disappeared, and he was discharged on August 25.

The reports on the examinations of the spinal fluid are shown in table 1. The cells were all lymphocytes. The initial pressure is reported in millimeters of water, the total amount of protein, sugar and chloride in milligrams per hundred cubic centimeters.

This was the second entrance of the patient to the hospital. In December, 1927, he had entered complaining of earache. A paracentesis was done with relief for a few hours. There was marked anemia, the red blood corpuscles being reported as low as 1,730,000 and 1,728,000 per cubic millimeter; the hemoglobin ranged between 35 and 45 per cent. On three examinations, there was blood in the stools; none appeared in the urine.

Blood transfusion was done on Jan. 2, 1928, and a few days later a mastoidectomy was performed, followed by ligation of the jugular vein. The patient

TABLE 1.—*Observations on the Spinal Fluid in Case 1*

Day	Date	Cells	Initial Pressure	Total Protein	Sugar	Chloride
1st	7/30/28	2,500	350	216	42	720
2d	7/31/28	.....	280	228	67	687
2d	7/31/28	.....	280	186	52	699
4th	8/ 1/28	1,479	300	132	75	687
5th	8/ 2/28	908	400	150	48	714
6th	8/ 3/28	800	260	132	41	728
7th	8/ 4/28	506	240	126	68	728
8th	8/ 5/28	274	140	126	56	719
9th	8/ 6/28	235	180	144	66	714
10th	8/ 7/28	286	300	138	55	728
11th	8/ 8/28	143	155	120	64	719
12th	8/ 9/28	152	150	63	60	714
13th	8/10/28	131	290	67	66	714
16th	8/13/28	115	265	47	64	687
18th	8/15/28	68	225	48	72	728
23d	8/20/28	39	250	60	60	687
27th	8/24/28	13	210			

was seriously ill for many weeks, but finally recovered, returning to his home in March. For three months he was free from symptoms until the onset of the present illness.

CASE 2.—L. E., a woman, aged 19, married, entered the hospital on Aug. 13, 1928, with a complaint of frontal headache. Her past history was unimportant. About four weeks before entrance she had had all the upper and three of the lower teeth removed because they were said to be abscessed. Ten days later, after severe exposure to wet weather, she developed a severe headache. The headache increased in intensity and was associated with a rise in temperature to about 102 F. The neck was stiff and sore, and she vomited four or five times before entering the hospital. There was retention of urine for three days, necessitating catheterization.

When she was admitted to the hospital, examination showed stiffness of the neck, a bilateral Kernig sign and some inequality of the pupils. The margins of the disks were slightly blurred. The temperature was elevated and ran an irregular course for the first two weeks in the hospital, varying from 97 to 102 F. During her stay in the hospital she had considerable headache, blurring of vision and some diplopia due to weakness of both external recti muscles. The fundi were normal. She was irritable and emotional. On repeated lumbar punctures the symptoms of headache, irritability, stiffness of the neck and diplopia disappeared, and she was able to be discharged on Sept. 12, 1928.

The observations on the lumbar punctures are reported in table 2. The cells were again all lymphocytes. The initial pressure is recorded in millimeters of

water and the total amount of protein, sugar and chloride in milligrams per hundred cubic centimeters.

Case 3.—Mrs. I. G., a woman, aged 35, entered the hospital on Aug. 23, 1928, with a complaint of headache. The headache had begun ten days before she was admitted to the hospital and was associated with vomiting. It was mainly occipital. The temperature had been slightly elevated to about 101 F. in the afternoons. The condition at the time of admission was one of semistupor, with marked irritability and resistance to examination. The neck was slightly stiff. The Kernig sign was not definitely positive. The margins of the disks were slightly blurred. She was noisy and made a great many complaints. There was some retention of urine, and catheterization had to be done. The temperature in the hospital

Table 2.—*Observations on the Spinal Fluid in Case 2*

Day	Date	Cells	Initial Pressure	Total Protein	Sugar	Chloride
1st	8/13/28	143	170	120	54	705
2d	8/14/28	134	510	47	70	714
3d	8/15/28	...	165	67	70	698
4th	8/16/28	233	95	57	85	714
5th	8/17/28	154	120	57	70	699
7th	8/19/28	133	108	69	82	690
8th	8/20/28	495	50	80	59	848
9th	8/21/28	199	120	67	71	666
10th	8/22/28	219	100	56	65	666
11th	8/23/28	93	110	50	63	Ins.
12th	8/24/28	56	...	74	65	Ins.
13th	8/25/28	48	100	44	52	679
15th	8/27/28	44	100	42	52	687
16th	8/28/28	13	120	46	..	...
17th	8/29/28	16	110	47	..	...
19th	8/31/28	26	90	48	61	781
22d	9/ 3/28	27	105	52	..	...
24th	9/ 5/28	35	75	43	..	...
28th	9/ 7/28	9	60	43	..	...

Table 3.—*Observations on the Spinal Fluid in Case 3*

Day	Date	Cells	Initial Pressure	Total Protein	Sugar	Chloride
1st	8/23/28	233	350	73	75	641
2d	8/24/28	288	200	52	54	638
3d	8/25/28	222	210	80	54	638
4th	8/26/28	...	196	98	63	679
5th	8/27/28	227	170	83	53	679
6th	8/28/28	244	150	91	..	...
7th	8/29/28	244	120	73	..	...
9th	8/31/28	117	250	64	46	760
11th	9/ 2/28	201	180	64	..	...
13th	9/ 4/28	100	200	64	53	...
17th	9/ 8/28	95	210	61	..	...
23d	9/14/28	28	220	39	..	...

varied from 98 to 100 F. She was relieved by lumbar puncture, which was done twelve times in twenty-three days. The essential observations are reported in table 3, the cells being all lymphocytes. The pressure is recorded in millimeters of water, and the total amount of protein, sugar and chloride in milligrams per hundred cubic centimeters.

Comment.—The following facts apply to all three cases: The Wassermann reactions of the blood and spinal fluid were negative throughout. No bacteria were seen in the spinal fluid, and cultures were sterile. Inoculations into guinea-pigs in all three cases gave negative results. The colloidal gold reactions were variable, but early in all cases there was a change in the middle range of the tubes. Four figures are given as examples of this change: 1112321000, 1111122200, 1112211000 and 1122332100.

In case 1 there is some reason to believe that one is possibly dealing with the late effects of a sinus thrombosis. An operation had been performed on the mastoid

six months before, and at that time there was definite thrombosis. On the other hand, it should be pointed out that this patient was free from symptoms for an interval of from two to three months between the two illnesses and that the second illness was similar in nature to that of the other two patients in all of its characteristics.

In case 2 the removal of so many teeth, probably abscessed, might be considered as an etiologic factor.

In case 3 no definite etiology was suggested. The condition in all these cases naturally was thought to be tuberculous meningitis at the time the patients were admitted to the hospital. They showed the usual signs of that disease except that the observations on the spinal fluid were not characteristic in that the chloride and sugar estimations were always within the limits of normal, whereas in most cases of tuberculous meningitis both the chloride and sugar estimations are below normal. It became obvious, as time went on, that these cases were not tuberculous meningitis. There were no polymorphonuclear cells in the spinal fluid; bacilli were never seen; cultures were sterile; inoculations into guinea-pigs gave negative results, and the illness, in each case, terminated in recovery. The second possibility of diagnosis which was considered was syphilitic meningitis. The repeated negative reactions to Wassermann tests, however, and the spontaneous recovery without antisyphilitic treatment were considered sufficient to rule out this disease.

Treatment.—The patients were treated by rest in bed and frequent lumbar punctures. The disease seemed to be self-limited. In case 1, an attempt was made to remove an increasing number of cells from the spinal fluid by "forced drainage." This method of treatment was not successful, for in each case, on the three times it was tried, fewer cells appeared in the spinal fluid evacuated finally than in that taken at the start.

These three cases could not be classified in any known type of meningitis. It was considered that they were unique, with the possible exception of case 1. There was no indication that the patients suffered from poliomyelitis, herpes zoster or parotitis, three well known causes of lymphocytic meningitis.

DISCUSSION

DR. FRANK FREMONT-SMITH: The three cases which Dr. Viets has reported present a picture which is sometimes called by the vague name of aseptic meningeal reaction, by which one means increased number of cells in the spinal fluid without the presence of organisms, usually due to a focus of infection in the neighborhood of the meninges. I think that in case 1 there is a probable focus of infection. Previous to the onset there was an acute disease of the mastoid with jugular thrombosis, because the jugular vein had to be tied. The picture of the spinal fluid is entirely characteristic and consistent with the jugular sinus thrombosis.

DR. H. C. SOLOMON: About eight or nine years ago I saw a boy who presented the clinical characteristics of tuberculous meningitis. The spinal fluid was likewise typical. Though he had previously had poliomyelitis, this was not to be considered. Within twenty-four hours after the lumbar puncture was performed. he was perfectly well. At that time I looked up the literature and found similar cases reported under the term "pseudo-tuberculous meningitis." One finds also, occasionally, a case reported as tuberculous meningitis with recovery. In all these cases the establishment of tuberculosis has been rather faulty. In the third case that Dr. Viets reports I saw the patient before he entered the hospital, and I made a clinical diagnosis of tuberculous meningitis. It had all the aspects of this condition. From Dr. Viets' previous experience he was anxious to have us withhold the prognosis for a time, and his expectations were borne out by the recovery of the patient. There were two other patients in the hospital during June and July with cases which were similar to those reported by Dr. Viets. In both cases, the spinal fluid showed a low sugar and low chloride content, which subsequently became normal. They had even a more clearcut serology simulating tuberculous meningitis than any of the three cases that Dr. Viets has mentioned. The house officer decided that something ought to be done and started treating

the patients with arsphenamine, on the basis that they might be syphilitic. In each instance, the Wassermann reaction of the blood and the spinal fluid was always negative, and the only thing suggestive of syphilis was that both patients recovered.

DR. VIETS: I am much interested in Dr. Fremont-Smith's comments. In case 1 there was mastoiditis followed by operation and jugular ligation, six months before the meningitis, but there was an interval of practically two months, in which the patient felt reasonably well, between the first and the second onset of the illness. This period seemed to me to be long enough to rule out the possibility of a connection between the disease of the mastoid and the later meningitis. It does not definitely do so, however, and I think that the possibility that case 1 is not like the other two deserves all consideration. All of the patients might have had poliomyelitis without paralysis. The age of the patients is, perhaps, a little beyond the usual limit, the third patient being 35. There was neither herpes zoster nor evidence of mumps. The cases mentioned by Dr. Solomon as pseudotuberculous meningitis are likely of this type. I started to put in this group the two other cases that Dr. Solomon mentioned, but because of the low chloride and sugar content I was a little doubtful about including them. They may belong to the same group. They certainly were cases of the same nature. Both patients had acute meningitis and recovered; it seems likely that the antisyphilitic treatment did not affect the outcome of the disease in any way.

THE MASSACHUSETTS REFORMATORY AND ITS PSYCHOPATHIC LABORATORY. DR. GUY G. FERNALD.

The problem of the reformatory is the detention, maintenance and reformation of inmates. The problem of the laboratory is the study of the personalities of the inmates for data of immediate utilitarian expediency and the adopting of means and methods of inculcating in inmates a driving desire and purpose to realize individual reformation.

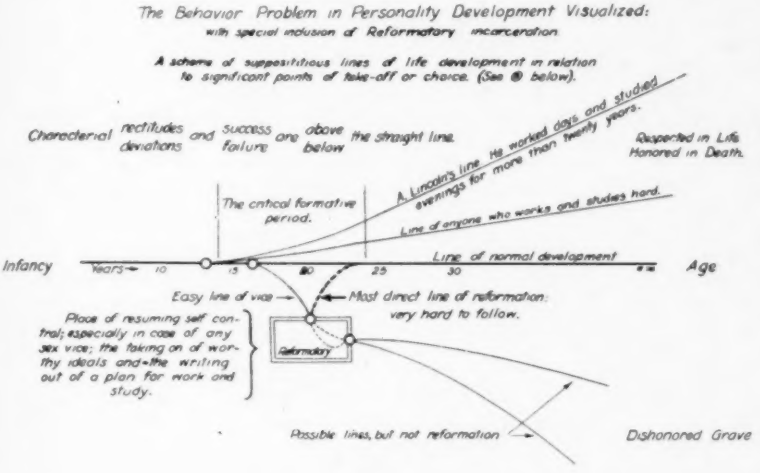
The inalienable capacity of the personality to choose behavior prevents the reformatory and all other extraneous agencies from reforming willy-nilly. Efforts to induce the choosing of well ordered behavior are limited, then, to the application of adapted external stimuli, and must always stop short of coercion. The judicious expenditure of much time and self-denying effort on the part of the inmate is requisite to the overcoming of the handicap he has incurred; an expenditure beginning during his incarceration and extending beyond his release sufficiently far to enable practice, face to face with the temptations of life, living as he plans to do while within the walls. So the concept obtains that the reformatory is a place of planning and preparation for reformation and character rebuilding and is like a preparatory school rather than a finishing school. Success in this life is achieved by taking a series of well chosen steps, and the inmate is handicapped by having taken many ill chosen steps in the formative period. Judicious planning and preparation within the reformatory and long practice at living successfully outside the reformatory are indispensable to ultimate success for the inmate. The theory of parole is founded on this concept which Cicero happily expressed as an axiom, "In all things, before beginning, a diligent preparation should be made."

In the study of the personalities of inmates the laboratory has recognized the fact that behavior reflects character rather than intelligence and that what one knows and can express reflects intelligence. No correct conception of "The characterial organization of the mind" could ignore the part played in behavior by habit, emotions and emotional stability, volition, etc. (conative). A correct conception of an intelligence (cognitive) may be represented, perhaps accurately, by a numerical score; however, for characterial deviations and rectitudes there is no human measure.

The psychiatrist's methods of personality examination and presentation afford a workable means of expression, and use of these methods has enabled the accumulation of some 4,500 laboratory case records, abstracts of which show an approximate intelligence age level rating and a brief description and characterization of the outstanding characterial deviations and rectitudes of the inmates examined.

In testing, any and all adapted tests have been utilized. The psychiatrist comes to have a variety of adapted and adaptable tests and stimuli. The one test relied on in most interviews to enable establishment of confidence and respect is the "Ethical Discrimination Test" which starts both parties to the conference into earnest study, whence the transition into the operation of the dual functions of the laboratory is natural and usually smooth. These dual functions are investigation and teaching. Tests are plentiful which enable the exercise of both, generally simultaneously, e. g., spell and define "vice" and "vise," or contrast handicap and disadvantage, or mistake and misfortune.

While the experienced psychiatrist plans the logical steps of the interview, he cannot foresee exigencies and would be hampered by any rigid program of tests to be applied. There are certain safeguards to be observed, however; general principles and tendencies rather than specific events and experiences are considered. Mischievous or childish attempts to take over the direction of the investigation, interruptions, evasions, empty excuses, needless delays and all destructive tendencies on the part of the inmate, whether intentional or otherwise, have to be tactfully



and consistently met and effectively handled. On the part of the examiner no promises or confessions are invited. Respect is commandeered by asking only fair (not leading) questions, and insisting tactfully on prompt, courteous and complete answers. "I don't know" is not a competent answer to a question calling for an opinion. The endeavor is to convince without depressing, to induce introspection without accusing, to simplify methods without miscarriage, to correct without abusing and to benefit by enabling rather than by bestowing. No stimulus is justifiable which does not tend to keep the inmate at his best. Suggestion is better than precept. One who fails to teach by example defeats his purpose.

Simple sex hygiene is taught to every arrival, in groups of ten or twelve. Every patient with venereal disease is given a special interview and separate notes are filed. At the laboratory interview, sex vice and sex hygiene is made an issue, but without quizzing. Suggestion is relied on and information is given. Gossip and personal experience are debarred. The basis for the teaching of sex hygiene in the laboratory rests largely on the significances of responses to a questionnaire submitted some years ago to 250 inmates, only three of whom tried to show in their answers that they had been free from sex vice.

The vital importance to the note-taker of taking notes of what is to be remembered and utilized has led to the stressing of this device in teaching inmates. In this connection and for other good purposes the questions, (*a*) When are you

at your best in this place? and (*b*) When are you at your worst? are sometimes asked. Among acceptable answers are: (*a*) When taking notes on this talk and (*b*) when taking part in some unworthy talk. So, while the laboratory cannot insist on reformation, it can commandeer consistently good behavior in laboratory interviews and can inculcate reasonable beliefs regarding reformation.

Either the accompanying figure or the "Five steps" teaching device is sometimes used.

1. To *really regret* the damage done one's life and other lives by the mistakes made.
2. To *intend* to do better.
3. To *make a plan* in writing for work and study for perhaps three to five years for realizing one's good intentions.
4. To *decide* and *determine* to stick to the plan.
5. To *practice living* the plan for the time determined on.

DISCUSSION

DR. A. WARREN STEARNS: It is gratifying to know that Dr. Fernald has kept to about the same position he had many years ago, and this in contrast to what one encounters in other states. I think one can almost say that there is a local attitude toward crime here. Last year, New York State gave only 14 per cent of criminals normal, 60 per cent psychopathic and the rest defective personalities. In a western state only 4 per cent were found to be normal. Dr. Fernald has in this group about 10 per cent abnormal and 5 per cent defective personalities. One of the first problems which I met in neurology was that of Friedreich's ataxia, and I learned that there were a number of descriptions of this disease by different people, making it seem to be several different diseases. One man had observed children; another adults. This may be the reason that psychiatrists do not present a more solid front in the field of criminology. Those working in the juvenile courts see only the problem of children. Dr. Fernald sees boys at what you might call the golden age of sex; others see advanced cases in state prisons. Perhaps this is why Dr. Fernald sees masturbation as such an important problem. The group which I, personally, have had to deal with are older men; for instance, murderers tend to be along in middle life in this state. About 75 per cent are not criminals in the same sense in which these fellows are; they have not been arrested before and their whole criminal career is represented by one emotional act. So they seem to be primitive persons and abnormal because they are living in a civilization not their own. Sex offenders in Charlestown State Prison tend to be older men. About 70 per cent of them have committed a technical crime. The age of consent in Massachusetts is 16 years, and the offenders come from races which mature early and present a much different problem from those with which Dr. Fernald deals. In my opinion, the most important part of Dr. Fernald's contribution is his recognition of the element of character. It was recognized in about 1834 that certain persons were inherently different from their fellows and the theory of the moral imbecile was advanced. Persons saw conduct which they did not understand. I remember Dr. Bullard presented a paper which dealt with the question as to whether a moral imbecile actually had intellectual defect. In psychiatry the use of new terms often seems to represent advancement. When the Boston Psychopathic Hospital was opened the term moral imbecile was ridiculed and in its place was substituted psychopathic personality, according to the kraepelinian concept. Later came the term constitutional inferiority and then constitutional psychopathic state. Now comes Dr. Fernald's characterial deviation. I think we have fooled ourselves by the substitution of new terms into thinking that we have made a great deal of progress in neurology. It is gratifying that Dr. Fernald has at last cast aside all these terms which mean so little and have no significance or place in psychiatric literature and has come back to the element of character. Criminals are persons who commit crimes and they are not essentially feebleminded or abnormal, except in the sense that their experience has led them to be social problems.

NEW YORK NEUROLOGICAL SOCIETY AND THE NEW YORK ACADEMY OF MEDICINE, SECTION OF NEUROLOGY AND PSYCHIATRY

Joint Meeting, Tuesday, Nov. 13, 1928, Under the Auspices of the Department of Neurology and Psychiatry of Cornell University Medical College

Chairman of the Academy Section, JUNIUS STEPHENSON M.D., *in the Chair*

A CASE OF SUBACUTE COMBINED SCLEROSIS WITH BENEFIT FROM DIATHERMY.

DR. THOMAS K. DAVIS.

A factory worker, aged 62, with an unimportant past history, had been temperate; he had been married for twenty years; his wife had never been pregnant. In May, 1925, he developed a numbness of the hands, which soon extended to the legs. That summer, considerable time was lost because a diagnosis of hysteria was made and he was sent to a sanitarium and given inappropriate treatment. He developed a sense of constriction about the waist and general weakness. When I saw him, there were: much hyperreflexia, but no definite signs of disease of the pyramidal tract; normal plantar reflexes; abdominal reflexes present; no disturbance of tactile or thermal sensibility, but grave disturbances of postural and vibratory sensibility. He could not recognize the movements of the toes and fingers. This made the use of the hands difficult; he could scarcely dress himself. In brief, the lateral and posterior columns were involved. The presence of subacute combined sclerosis was confirmed when it was found that there was no free hydrochloric acid and a low total acidity in the gastric secretion. A blood count at that time showed: 65 per cent hemoglobin; red cells 3,300,000, with monocytes, microcytes and polychromatophilia. A tentative diagnosis of a pernicious type of anemia was made. The patient was placed on the usual regimen for such a condition — large doses of hydrochloric acid, a diet containing liver and of high caloric value, with thyroid and injections of sodium cacodylate. He was seen only at intervals, but by May the anemia showed improvement. By May, 1927, a blood count showed: 73 per cent hemoglobin and 4,200,000 red cells; in September the hemoglobin was 75 per cent, and the red blood cells numbered 4,100,000. During that year the blood picture became relatively normal. During that time, however, he did not regain the use of his hands, nor was there any reduction in the numbness and subjective disabilities. In February, 1928, more than a year after the regimen for pernicious anemia was instituted, he was admitted to the hospital, where it was possible to give diathermy; the other measures were also continued. Diathermy was given for twelve weeks, at first three times a week and soon afterward every day, for fifteen or twenty minutes, the electrodes being placed over the cervical enlargement. The electrodes, of equal size, were about 4½ inches in diameter. Under that regimen he made greater progress than before. He became able to dress himself, lost the tight sensation around the waist, and the tingling and numbness of the hands disappeared.

I thought it worth while to report this case of subacute combined sclerosis because it appears that diathermy, added to a regimen which had been used for a whole year, brought about a special and additional improvement. Naturally, it is not claimed that the results in one case prove that this will always be useful; but at least in one case it helped, and one should consider adding this method to the therapy for such conditions.

DISCUSSION

DR. JUNIUS STEPHENSON: I am especially interested in Dr. Davis' remarks, as I have advocated diathermy in the treatment for multiple sclerosis. Dr. Hirsh is an authority on electrotherapy and I should like to hear from him.

DR. A. BERN HIRSH: The experiment carried on at the Rockefeller Institute lately and reported in the *Journal of Experimental Medicine* in a series of four

papers are conclusive as showing that one can thoroughly heat an internal part of the body by means of the particular high frequency current called diathermy. The question then comes up, if one can so heat it, whether the action must not be that of friction of the tissues. In other words, although it is not yet possible to prove it experimentally, there occurs a molecular massage. If that does occur, it would readily explain why one can act on organic tissue, in this case cord structure, in the way the speaker has mentioned.

For the sake of comparison and later study, it might be well, in reporting these clinical cases, to give the exact technic used in the procedure; to describe the kind of apparatus used, with the name of the maker or the type of machine from that maker; then how the current is used; how many milliamperes of current are employed, and the time required at each séance in slowly building up to the maximum of current in each application. If that is done, it will help toward more general knowledge of what one believes to be a useful method for reaching organic conditions in the cord and so directly influencing them.

Dr. Israel L. Feinberg: I agree with Dr. Hirsh. We are much indebted to Dr. Davis for making this report but, in giving treatments of this kind, it is important to know: exactly the milliamperage; whether a wet or a dry electrode is used; the length of time of treatment; the duration of the treatment, and various other incidentals. Diathermy is simply the old d'Arsonval current. There is no question that diathermy currents have a selective action on scar tissue. This is proved, whether it is scar tissue of superficial nature in deeper structures or organic scar tissue. Much has been claimed for it in internal organs, but the spinal cord seems to be the tissue that is the hardest to reach, the reason being that in addition to going through soft tissue, the current has to pass through the bony wall of the canal.

Dr. C. E. Atwood: I have seen three patients with subacute combined sclerosis. All were men over 60 years of age. In all, the earliest symptoms noted were numbness and tingling, especially in the sacral distribution. The disease progressed rapidly into complete helplessness and emaciation, with death in a few months. I am surprised that Dr. Davis' patient has lived so long. If any remedy can be found, even by experimentation, I believe that its employment is justifiable in this comparatively rare disease.

Dr. Michael Osnato: Was there any change in the neurologic status of the patient, particularly in reference to the disturbances of postural and vibratory sensibility? We have all had experience with the variety of combined sclerosis associated with pernicious anemia and cachexia, and we know that in these cases, when the anemia disappears or there is a remission after treatment, the neurologic signs do not clear up. The treatment instituted for the anemia—transfusion, the liver extract, diet, and other measures—frequently causes great improvement in the anemia, but most of us have found that the neurologic status of the patient—the difficulty in locomotion, the Romberg sign, the disturbances in sensation—are not affected and do not share in the general improvement. I wonder if that was the case in this patient.

Dr. Junius Stephenson: The treatment for multiple sclerosis by diathermy differed from the results with silver arsphenamine. In the treatment for multiple sclerosis by diathermy, in addition to the objective improvement there was an improvement in that the Babinski sign and other neurologic symptoms disappeared. Just why it did not disappear after the administration of silver arsphenamine and did disappear with the diathermy I do not know.

Dr. Thomas R. Davis: In reply to Dr. Osnato, the posterior column signs did not return as far as I could demonstrate by the usual tests. However, function was certainly helped, for the gait became better; the patient had less tingling in the fingers, and he could dress himself better.

I agree that I should have described diathermy more accurately than I did. It was given at the institute by the electrotherapeutist in charge of the electrical department, and I know that the milliamperage went from 1,000 to 1,200. The

electrodes, as I said, were circular and metallic, 4½ inches in diameter. The treatment lasted for about twenty minutes, but I cannot say how long was taken to reach the maximum.

A Case of Multiple Peritheliomas of the Brain. Dr. George Hyslop and Dr. Lewis Stevenson.

Multiple primary tumors of the brain are unusual. Dr. Irving Sands of Brooklyn reported a case before this society about two years ago in which two tumors were found. The first was classed as an endothelioma, and the second as an angioma. In Ewing's textbook, Haenel is quoted as having reported, in 1896, five histologic varieties of primary tumor of the brain occurring in one patient. In general, multiple primary tumor of the brain offers clinical difficulties not only as regards localization, but even with respect to the etiologic diagnosis. The case we are presenting is of some clinical interest and also of value because of the histologic problem involved.

A man, aged 40, had not had venereal disease, and his past history was irrelevant. In November, 1927, he struck the back of his head on a boiler and fell forward, striking his nose. There were no evidences of skull or intracranial injury, nor was there any concussion. About two weeks later, generalized headache and vomiting with nausea commenced. These continued through the winter, and in April hoarseness and blurring of vision developed. Details of visual impairment were difficult to obtain. By June the patient was completely blind, and he gradually developed a marked somnolence. There were no other symptoms. He was admitted to Bellevue Hospital on June 28.

Repeated examinations revealed variable symptoms which made localization difficult. A slight disturbance of the pyramidal tract on the left and retropulsion; weakness of the sixth and seventh nerve on the left and a slight unilateral sensory impairment which was finally interpreted as a hyperesthesia on the left side of the body were found. There was marked papilledema with retinal hemorrhage. The patellar reflexes were consistently absent. On one or two occasions, a larval nystagmus to the left was observed.

The spinal fluid did not show any increase of cells or globulin, and the serology was normal. Roentgen examination of the skull did not show any abnormality, not even evidence of increased intracranial pressure.

The clinical diagnosis was tumor, but there was no agreement as to localization, although both the right frontal lobe and the vermis or left cerebellar hemisphere were considered. An exploratory operation on July 6 did not give help either to the examiners or to the patient. The man died suddenly on August 4.

A complete autopsy was done. Multiple tumors were observed on the surface of the brain, and on gross examination seemed to be angiomas. There were no abnormalities of any of the thoracic or abdominal organs.

Comment.—1. Clinical: The onset of symptoms soon after a slight injury to the head offers opportunity for speculation. Ewing quotes Adler who found that injury to the head was seemingly causally related to the onset of tumor of the brain in 8.8 per cent of 1,986 cases. This is a greater incidence than is the case with malignant tumors elsewhere in the body, with the exception of cancer of the breast and bone sarcoma. Specifically, injuries of the head are not to be causally related to tumor of the brain unless the trauma is capable of producing a lesion of the brain, in which the damaged tissue may undergo a neoplastic transformation; nor is there any causal relation unless symptoms of tumor appear immediately or within a brief time. In the case here reported, it is conceivable that even a slight blow on the head might well influence the course of a pre-existing neoplasm.

We cannot explain the early appearance of blindness; internal hydrocephalus or pressure on the chiasm was not present, and we could not find any tumor tissue along the secondary optic pathways. The lack of clearcut localizing signs, of course, required the consideration of some form of encephalitis, syphilis or metastases from malignant tumor elsewhere in the body.

2. Pathology (Dr. Lewis B. Stevenson): Perithelioma of the brain is rare. Cushing and Bailey refer to five cases in a series of more than 500 verified tumors of the brain. Usually, perithelioma of the brain is a single tumor.

This brain was the seat of multiple tumor nodules varying in size from a few millimeters to 3 cm. in diameter. In the left hemisphere was a nodule 2 cm. in diameter in the frontal lobe, about the middle of the second frontal convolution. There was a small nodule 0.5 mm. in diameter in the left occipital pole with one or two miliary nodules elsewhere. These masses were all subcortical. There is apparently some softening in the internal capsule and to a less extent in the lenticular nucleus of the left side. There was a nodule in the cerebellum 1 cm. in diameter in the midline in the uvula.

In the right hemisphere were four large nodules from 2.5 to 3 cm. in diameter, all appearing on the surface: one in the right frontal lobe involving the posterior end of the second and third frontal convolutions; another near the vertex about the top of the precentral gyrus, and two in the right parietal lobe, one of them in the region of the supramarginal gyrus and the other far down in the junction of the parietal and occipital lobes.

In this hemisphere also there were one or two miliary nodules. The ventricles were apparently not dilated. Sections were taken from nodules in both hemispheres, and these showed the typical structure of a perithelioma or, as some authors call it, a perivascular sarcoma, the unit of the tumor being a roset of elongated cells arranged about a thick walled blood vessel.

The tumor cells a short distance away from the vessels had become necrotic, and these necrotic areas were filled with large, fat granular corpuscles. The tumor cells seemed to be growing from the outer layers of the thickened blood vessels. In many regions the blood vessels had become so thickened that there was little if any lumen left. This resulted in a complete disappearance of all the tumor cells near these occluded vessels. Some portions of the cortical tumors resembled an angioma on section.

The tumor with which perithelioma is most likely to be confused histologically is the ependymal spongioblastoma. In the latter the cells are also arranged in rosets, some of them about the blood vessels and some not. In spongioblastomas of this type, the delicate fibrils attached to the cells are readily demonstrable by Hortega's silver carbonate stain, and this alone would almost be sufficient to differentiate the two tumors. Again, the protoplasmic granules in the cells of these spongioblastomas are characteristic and are not present in the cells of the perithelioma. Another point of contrast is the peculiar tendency of the spongioblastoma to form ependymal surfaces, and there is no evidence of this in the perithelioma. Necrotic foci laden with gitter cells are typical of the perithelioma and have not been present in our spongioblastomas to any such extent. In the rosets of the spongioblastoma, the blood vessels are so loosely attached to the tumor cells that they frequently are seen to have dropped out of the section. This is not true of the tumor under discussion in which the tumor cells seem to be much more a part of the thickened wall of the blood vessel. There is, moreover, in the perithelioma a characteristic proliferative reaction in the vessels. As we have indicated, some parts of the tumor consist of nothing else but thickened blood vessels surrounded by areas of necrosis without any tumor cells left, and in many of these vessels the lumen has been entirely obliterated.

Tumor nodules were not visible in the brain stem, the pons or medulla to explain the sixth and seventh nerve palsies and other signs. The blindness was evidently due to secondary optic atrophy, with considerable proliferation of astrocytes in the optic nerves.

DISCUSSION

Dr. J. H. Globus: Dr. Stevenson has made out his case and established the nature of the neoplastic lesion. I agree with him that this is a perithelioma and that it is not a spongioblastoma with multiple centers of growth. In the attempt to classify glioblastic tumors, he made a few minor errors in identifying spongioblastic ependymoma and in stressing the diagnostic feature of granules within some

of the cells. All these tumors in the brain that he showed are apparently of the same character. The specimen is rare. In my own experience, in a group of from 120 to 130 tumors, there was only one instance of multiple endothelioma.

DR. J. W. STEPHENSON: Dr. Hyslop discussed the relation of trauma to primary tumors of the brain; I should like to hear from some of the clinicians about this.

DR. E. D. FRIEDMAN: Some time ago, in a discussion of the etiologic relationship between trauma and the development of neoplasms of the brain, I ventured the hypothesis that trauma may stimulate glia production in the brain, and that the healing process may not stop at the point at which ordinary reparation takes place but may go on to the production of gliomas. This is a belief to which I still hold today, although I do not have a large number of statistics to martial in support of this belief. Many German observers have noted this sequence of events, without offering any explanation. It has considerable bearing on medicolegal problems. Oppenheim was definitely of the opinion that there was a causal relationship between trauma and a certain number of neoplasms of the brain.

DR. MICHAEL OSNATO: I do not believe that Dr. Hyslop intended to give the impression that the trauma had anything to do with the development of these multiple tumors. It was purely a coincidental relationship because, as I understand it, the patient's symptoms came on within a few weeks after this minor injury. Several years ago, Frazier (Frazier, C. H., and Spiller, W. G.: The Successful Removal of Brain Tumors, ARCH. NEUROL. & PSYCHIAT. **6**: 476 [Nov.] 1921) made some remarks concerning a tumor 6 cm. or more in diameter, and said that it probably was several years at least in the process of development. He also stated that tumors of the brain are, as a rule, slow in growth. The smallest of the tumors in Dr. Hyslop's case is certainly so large that it could not have developed within a few weeks after the injury. I fail to see how one can connect the trauma with the symptoms of tumor which merely developed coincidentally several weeks later.

One should be careful in expressing opinions in this connection because of the medicolegal questions that come up. The truth is that practically nothing is known about the possible influence of a single trauma to the head in producing a tumor of the brain. One can only draw on one's own clinical experience with neoplastic conditions, such as epithelioma of the tongue or the lips and cancer of the breast, in which persistent continuous, irritative trauma is said to be a factor in the production of the neoplasm. The rôle which trauma may play under such circumstances is understandable, but I do not believe that pathologists or clinicians want to go on record even speculatively as saying that a single blow to the head might bring about a neoplastic situation in the brain. Of course, with bone sarcoma, clinical experience teaches that tumor may follow a single trauma, but there is no evidence that such a thing occurs in the brain.

DR. GEORGE HYSLOP: I am glad that Dr. Osnato spoke as he did. It was not our intention to imply that trauma was actually an etiologic factor in this case. The vascular nature of the tumor is such that trauma might possibly have had an "activating" influence. These multiple tumors probably existed before the trauma, and the injury to the head may have exerted pressure, some molecular disturbance may have occurred, and thus have aggravated the preexisting process. Dr. Osnato referred to the difficulty in asserting that any blow might initiate any neoplasm. I think that statistics for carcinoma of the breast and sarcoma of the bone require one to place the relationship between trauma and malignant tumors in a separate category. The incidence of trauma is much greater in these than in any other type of malignant disease, and trauma in these two types of malignant condition often appears to have a direct etiologic relationship. The criterion referred to by Ewing for a relation of trauma to tumor is that the tumor should be of a variety that could start from the tissue injured by the trauma. We are all familiar with the type of malignantly developing spongioblastoma in which, in a period of from four to six weeks after the onset of symptoms, the patient comes to the operating table and a large tumor is found. In such cases the symptoms

are usually entirely independent of any preceding trauma or any systemic infection. I deliberately introduced this question into the presentation, because it seemed to me that there is, as Dr. Osnato implies, a lot of nonsense said with regard to the relation between injury and anything which happens to a patient afterward.

OCULAR DISTURBANCES IN EPIDEMIC ENCEPHALITIS. DR. FOSTER KENNEDY.

It has been a habit to speak of encephalitis as though it were a totally new disease, but in 1718, "Schlaffkrankheit" was described by Camerarius, who noted the difficulty in raising the eyelids, and in 1875, Gayet wrote of "ophthalmoplegia of subacute onset and accompanied by apathy and somnolence." In these cases, the double ptosis and bilateral third nerve palsy with divergent strabismus were present.

Another consideration of the ocular manifestations in epidemic encephalitis is now in order in that new cases of this disease have been appearing lately. It is inevitable that the variety of symptoms must be extreme; a widespread neurotropic infection must produce a great many different disease pictures which will vary with the structure affected. Variety in such pictures is furthered also because from lesions of the nervous system may come either obliterations of normal functions or release of functions normally controlled by centers higher up. It is possible also that the variety of clinical form may be produced by the variety of virus or by a constant virus varied by appearing in different evolutionary phases.

The forcible, spasmotic shutting of the eyes may last so long a time as to make it necessary for the patient to be led about, as though blind. Ptosis of the eyelids is a frequent symptom of encephalitis, and is often found in association with weakness or paralysis of both external recti; perhaps as Ward Holden said, this particular combination of involvement of the third and sixth nerve is peculiar to this disease. However, it must be emphasized that the grimacing, violent closure of the eyes to which I have referred as blepharospasm has nothing physiologically in common with ptosis; ptosis is due to a direct attack on the third nerve or nucleus; blepharospasm occurs through the pouring down of an uncovered stream of tonic impulses from basal ganglia freed of their normal cortical government. In several encephalitic patients, Holden described a well marked "paralysis of divergence" in which, with normal mobility of the eyes, they focus on a point about 15 cm. away and singly, while at a greater distance there is homonymous diplopia in every direction of the gaze. I have observed definite spasm of extrinsic eye muscles in the acute period of this disease which produced appearances of skew deviation, as those with which one is familiar in cerebellar disease of the middle peduncle. Transient diplopia, usually accompanied by strabismus, is perhaps the most frequent single diagnostic feature of the early stages of encephalitis, and the histories of passing double vision in many patients suffering from paralysis agitans furnish the clue to the origin of the condition. It seems to me probable, therefore, that this early diplopia may indeed have been only the result of paralysis of divergence through spasm of the recti, especially as muscle spasms of striatal origin are common occurrences elsewhere.

Rhythmic movements have been seen in extrinsic eye muscles, though not always affecting both eyes in conjugate movement. These movements have been seen to affect only one eye at a time in four patients, the regular jumping of one eyeball in one direction furnishing a highly startling and somewhat uncanny appearance.

All possible palsies may occur in single or associated muscles with variations of severity, due possibly to a perivascular lymphocytic infiltration especially affecting the brain stem around the aqueduct by an interstitial infiltration of cranial nerve fibers by lymphocytes.

Especial incidence is apt to occur in the region of the quadrigeminal plate, producing the Parinaud syndrome, a diminution or loss of conjugate associated movements of the eyeballs upward or downward or, less commonly, interference with lateral conjugate action.

While these losses of muscular function occur commonly in the acute stage, they may be solely progressive for several years in cases that become chronic.

Neoplasms can give rise to localized iridoplegia for brief periods; so lesions with peculiar incidence in the mesencephalon must frequently interfere with

pupillary actions, must often make pupils irregular and unequal temporarily, for long periods or permanently, and not rarely produce the Argyll Robertson phenomenon. In addition to the Argyll Robertson pupil one may find a paresis of accommodation which, as an isolated occurrence, one is accustomed to see in diphtheria alone. Ward Holden stated that this paralysis of accommodation in encephalitis is usually bilateral.

Nystagmus is almost the rule in acute encephalitis and may be of both cerebellar and labyrinthine varieties, that is, it occurs in both lateral and vertical directions. Further, it is often characteristic in its extraordinary "electric-like" rapidity. It is not my experience that nystagmus is never static and present on ocular movement. The rapid shivering movements of the globe are present at rest and are usually accompanied by sensations of intense dizziness; they probably emerge as a result of implication of Deiter's nucleus or the central vestibular connections.

Only once have I met a true retrobular neuritis in this disease. In that case a central scotoma was easily demonstrated in the left visual field, and temporal pallor of the disk ensued later. During the height of this episode, rapid contraction of the pupil to light followed by rapid dilatation, despite the maintenance of illumination, occurred. It is probable that transient retrobulbar neuritis is commoner than has been supposed; the lack of cooperation in most encephalitic patients would tend to cause this condition often to be overlooked.

Papilledema in epidemic encephalitis is not common. Holden found 1 case out of 100 patients seen at Mt. Sinai Hospital and 1 out of 20 at the Neurological Institute. On the other hand, I was able to associate a number of patients together as a clinical encephalitic group in which the late occurrence of papilledema was a constant feature of the disease.

DISCUSSION

DR. MICHAEL OSNATO: There is little to add to this comprehensive review. One thing occurs to me in connection with Dr. Kennedy's observations concerning the Argyll Robertson pupil, that is, if I remember correctly, the definition that the Argyll Robertson pupil has four characteristics: it is small, does not react to light and does react in accommodation; it shows also the absent reaction to consensual stimulation and irregularity of outline. If one keeps these in mind, one can still safely say that one never finds the Argyll Robertson pupil except in persons with syphilis of the central nervous system. In the few cases of so-called Argyll Robertson pupil encountered in epidemic encephalitis, the pupil has not been small. It has been large. This is an important difference and not the only one between the pupillary symptoms of these conditions.

As far as the papilledema is concerned, it has not been my experience to meet it frequently. I have observed only two instances. In one, the papilledema led to a craniotomy in another hospital. It has not been our experience in the wards at the New York Post-Graduate Hospital to find much swelling of the disks at any time during the course of the disease, and in the two cases in which it was definitely found the extent of the swelling did not at any time amount to more than 2 diopters. In both cases the follow-up study showed that a secondary optic atrophy took place, in one practically limited to one disk.

DR. I. S. WECHSLER: I, too, have seen one case of retrobulbar neuritis in encephalitis. I saw that patient from the first day of the illness and she had all the classic signs and symptoms of encephalitis, including ocular signs, lethargy and pleocytosis. After one year, the picture changed from a typical encephalitis to one of multiple sclerosis. I do not know whether the latter was a result of the former.

A few questions occurred to me when Dr. Kennedy spoke of the Argyll Robertson phenomenon. His explanation sounds plausible, but I do not know whether one can invoke it in all cases. I have seen, for instance, the Argyll Robertson pupil in tumors of the pons. The Argyll Robertson pupil has been explained by lesions of the ciliary ganglion of the Edinger-Westphal nucleus and of several other regions. The conception of Hughlings Jackson's release phenomenon in

reference to encephalitis may be applied perhaps to psychogenic conditions. I have seen one encephalitic patient who had upward spasms of the eyes, but in addition she developed a typical compulsive neurotic phenomenon. The eyeballs would go up at frequent intervals, for hours at a time, and she had a compulsion to look at people in the intervals when she was free from the tendency to look upward.

The presence of tics, too, is extremely important. It is a question whether many of the tics which are interpreted as hysterical are not in reality manifestations of some organic process which one cannot determine. Their occurrence in encephalitis lends weight to such a supposition. It also occurred to me that the stammering in encephalitis may be compared to the propulsive phenomenon in paralysis agitans. The speech seems to have a festinating character—a halting, alternating with a running forward.

Dr. Russell G. MacRobert: Some of the patients who had papilledema to whom Dr. Kennedy refers I also saw at the Neurological Institute. I saw another patient elsewhere, a young woman who presented a typical picture of epidemic encephalitis. Presently, however, there appeared marked papilledema with hemorrhages, and she began to lose her sight. A few weeks later, as she reached a point of almost complete blindness, a decompressive operation was performed. The brain appeared to be edematous. A few days later, she died. An autopsy confirmed the diagnosis of epidemic encephalitis.

Dr. George Hyslop: Dr. Kennedy referred to the Argyll Robertson pupil. In epidemic encephalitis there is a reversal of the usual reflex impairment so that the loss is in accommodation, whereas the pure light reflex is retained. Furthermore, papilledema in the patients with epidemic encephalitis to whom Dr. Kennedy referred must be distinguished from the papilledema due to increased intracranial pressure. In Dr. Kennedy's cases the rapid onset, the marked visual disturbance, the abundant vascular changes in retinal vessels and the distinct involvement of the choroid are as a whole not associated with increased pressure from expanding lesions. As far as simple hyperemia or a low grade papilledema in epidemic encephalitis is concerned, Ziegler recently reported a series of several hundred cases of epidemic encephalitis, and stated that some degree of papilledema was not an uncommon observation during the acute stages of the disease. I am not sure, but I think that about 10 or 14 per cent of the patients showed this sign. It can be readily seen that simple papilledema is quite different from the acute changes in the fundus referred to by Dr. Kennedy.

Dr. Walter M. Kraus: I recall talking with Dr. Kennedy eight years ago about the occurrences of ocular changes in diphtheria. We were greatly interested and somewhat puzzled about the pathway of infection from the nasopharynx to the mesencephalon. Perhaps the explanation may be that the nasopharynx is the most forward end of the body. The tip of the body lies about 1 cm. above the tip of the nose. The most forward end of the segmental nervous system is the cephalic end of the mesencephalon. Immediately anterior to it lie the nuclei which control the visceral nervous system, and among these nuclei surely are some which control, in some manner, the mechanism of sleep. Immediately caudad to these nuclei are those which control the eye muscles. I think that it is fair to present the hypothesis that there is a pathway of infection from the forward end of the body, so far as its external part (the nasopharynx) is concerned, and the forward end of the nervous system, which is situated in the mesencephalon. The oculomotor nuclei in the most cephalic segments may thus be affected early in disease, the portal of entry of which is the nasopharynx.

Dr. Thomas K. Davis: I was interested in the brief reference to the appearance of hippus in retrobulbar neuritis. Dr. Kennedy referred to the fact that the light thrown on the retina caused rapid contractions of the pupil followed by rapid dilatation despite the maintenance of illumination. Does Dr. Kennedy believe that hippus, when it occurs, always indicates the presence of some degree of retrobulbar neuritis?

Dr. Foster Kennedy: I accept, in a sense at least, Dr. Osnato's discussion of the Argyll Robertson pupil. The "Argyll Robertson" pupil is, within limits, much

what we like to make it. It is like Humpty Dumpty's words, which "meant what he meant them to mean," irrespective of their dictionary significance, and the Argyll Robertson pupil may be looked on in that way; one uses "Argyll Robertson pupil" to describe pupils which have lost or are in the process of losing their reaction to light, more than they have lost or are in the process of losing their reaction in accommodation, irrespective of their size. I grant that Argyll Robertson said that his pupil was myotic, a tiny pinpoint pupil, which had lost its reaction to light and had not lost its reaction in accommodation; what Argyll Robertson did not understand was that this was only a stage in the development of a pupil which was eventually destined to lose its reaction both to light and in accommodation. The Argyll Robertson pupil has many stages. I was using the term in a general sense, rather than in the particularized sense of the original description of the pupil, with apologies to the shade of Argyll Robertson.

Dr. Wechsler spoke of his case of retrobulbar neuritis, which later turned out to be disseminated sclerosis, but it was not clear from what he said whether he thought the original picture was that of a disseminated sclerotic process or the patient had two diseases.

DR. I. S. WECHSLER: I do not know.

DR. FOSTER KENNEDY: That makes it harder. The patient that I described as having the central scotoma and definite retrobulbar neuritis now has an advanced form of parkinsonian disease, so that there is no question about the nature of her condition.

The idea of the control by the cortex of the lower, phylogenetically younger, centers might be invoked to account for some of the libidinous and nonmoral characteristics which become evident in cases of encephalitis. Who knows but that the basal ganglia may be the reservoir in our brains of great horror which in the microcosm of our lives has become overlaid and controlled! There may even be a union between organic science and Freud's dogmas in that idea!

Dr. Davis spoke as though he thought I was using my description of the retrobulbar reaction as synonymous with hippus. That was not my intention. As I understand hippus, it is a constant backward and forward contraction and dilatation of the pupil. That was not what I meant when I spoke of the retrobulbar reaction. By the retrobulbar reaction I meant the reaction one sees when the inflammatory exudate from a sphenoidal sinus, for example, has fallen on one optic nerve and not another; what I mean will be evident when one can contrast one pupil with the other unaffected pupil, if the light is thrown on the affected eye. It will come down as promptly as the other one, but it will immediately go back and will remain dilated, although illumination is maintained. It does not work backward and forward as it does in hippus.

I wish to thank Dr. McRobert for his confirmation at autopsy of the papilledema with encephalitis. That is rare. It is hard to find these cases, because a good many patients with encephalitis and papilledema recover, and to prove the sum is not so easy.

The value of Dr. Kraus' contribution, the interesting clinical fact that the midbrain is often the earliest site (the fountain of origin) of the infections of the nervous system, lies in the fact that this site (the mesencephalon) would seem to be of one of the most protected and remote parts of the nervous system. Encephalitis, syphilis, tetanus, diphtheria and a great many cases of poliomyelitis strike the midbrain; however, one of the difficulties in using Kraus' explanation as a satisfactory reason for all of this location and incidence of disease in the mesencephalon is that in many of these diseases the infections are hematogenous. If there is an anal infection in diphtheria, a cauda equina neuritis with dropfoot will often occur as a local manifestation of that disease, but at the same time a paralyzed pupil will appear. I do not know whether this is due to the tip-tilting of the mesencephalon or not. Of course when tetanus develops after a bullet wound in the leg, nearly the first thing that one finds is trismus, which, of course, is due to irritation of the motor root of the fifth nerve in the mesencephalon. However, the topography of the midbrain segments gives little explanation of this phenomenon.

CONTEMPORARY DESCRIPTIONS OF THE MUSCULAR SYSTEM. DR. WALTER M. KRAUS and DR. CHARLES DAVISON.

Tables were shown from eight well known American, English, German and French textbooks on anatomy. Piersol's "Human Anatomy" gives the best of these classifications. The topographic criterion, however, dominates in all. The data gained from phylogeny and embryology are almost entirely omitted. The student loses the idea of the muscular system as a whole as well as the idea of the relation of muscle groups to each other and their development from a definite sequence.

The following simple classification is proposed:

I. Axial Muscles.
  A. Muscles of the Preotic Segments.
  B. Muscles of the Branchial Segments.
  C. Muscles of the Trunk Segments.
    (*a*) Episomatic (dorsal).
      1. Transversospinalis group.
      2. Longissimus group.
      3. Iliocostalis group.
    (*b*) Hyposomatic (ventral).

II. Appendicular Muscles.
  A. Muscles of the Upper Extremity.
    (*a*) Dorsal group.
    (*b*) Ventral group.
  B. Muscles of the Lower Extremity.
    (*a*) Dorsal group.
    (*b*) Ventral group.

For purposes of guiding the student in dissection, this classification is simple and adequate. The muscles of the head are grouped, as are those of the trunk and limbs. Those of the trunk are divided also into those of the back of the body and the rest. If the arm or leg is to be dissected first, the student can easily turn to section II.

How can the clinician and the neurologist, in particular, who regards the muscular system as an important group of end-organs of the nervous system, expect to have an orderly idea of the muscular system as a whole if this is not given by the anatomists? Certainly the cranial and spinal nerves are described in their proper order; why not the muscles? The phylogeny and embryology of the nervous system have made its functions more understandable, and the same approach will clarify the significance of the muscular system. To know muscles as such without any knowledge of how they are related is as sterile as to know that there is a pons and a cerebellum without knowing their relation. To describe muscles in so unsystematic a fashion as is done as a rule in anatomic texts is as useless as to describe the nervous system in some such order as cortex, anterior horn cells, ulnar nerve, thalamus and then stellate ganglion.

The classification which we suggest gives some of the information of phylogeny, some of the information of embryology, a sequence from the head-end to tail-end of the body, an opportunity to understand the muscular system as a whole, and finally a basis for uniformity of description in texts on anatomy.

DISCUSSION

DR. FOSTER KENNEDY: I am glad that the neurologist is the person to put his finger on the unscientific attitude toward a large part of anatomic science that the anatomists hold. I have thought for a long time that the anatomists have almost no affiliation with clinical medicine, and Dr. Kraus' exposition has shown that they have little affiliation with phylogeny either. The neurologists have done much toward the improvement and changed attitude of the clinician in internal medicine, but even now a good many of the hospitals allow their interns to write their notes on a patient from above downward,

describing the head, chest, abdomen and legs, just like a layer cake. I think an investigation of the hospitals, such as Dr. Kraus has conducted on the books on anatomy, would show that this too obvious method of note-taking extends through a good many of the internal medical wards; we neurologists have done something toward making clinicians look on man as a series of interrelated physiologic systems. Dr. Kraus has done the same thing for the anatomists. It is clear that in textbooks on anatomy the musculature is not described in scientific manner. It is as if one tried to describe a tree by describing each separate leaf without any relation to the kind of tree, or the physiology of the tree, or how that tree grew from its seedling. I am sure that Dr. Kraus is embarking on a missionary effort of great importance if he can preach his doctrine to the pure scientists who live in a world transcendental and remote.

Dr. Henry A. Riley: I feel much as Dr. Kennedy does in regard to this pioneer work of Dr. Kraus, and I think that it has a great deal to commend it. Many of us are interested in classification, and perhaps the time has come when it may be profitable to spend some time on such avocations. Our progenitors have spent generations in collecting data, but they have been so occupied in collecting the data that the task of correlating and classifying it has possibly lagged somewhat behind their investigative efforts. I believe that, as we now have fallen heir to all of this material which has been described and collected, it is time for us to set about the task of arranging it in the most satisfactory form, so that it will be accessible in a logical and understandable way to those who are to use it. I am in entire accord with what Dr. Kraus has done. He has assumed a labor of love in going through these dusty tomes, and I know that he will produce something out of it.

PHILADELPHIA NEUROLOGICAL SOCIETY

Regular Meeting, Nov. 23, 1928

N. W. Winkelman, M.D., *President, in the Chair*

Familial Muscular Dystrophy in Three Members of the Same Family with Loss of Tendon Reflexes in All. Dr. Alfred Gordon.

The father and son show unusually great resemblance in their disorders. Both arms are atrophied to the same degree, and they are ankylosed at the elbows. They cannot extend their arms fully in the upward direction. The supraclavicular and infraclavicular fossas are exaggerated because of atrophy of the corresponding muscles, more on one side than on the other. The power of the biceps and triceps muscles is diminished. The pectoral muscles in the father are also involved. The small muscles of the hands of the father (not of the son) are markedly atrophied. The grip of both hands is diminished more in the father than in the son. The muscles of the forearm are also involved but to a lesser degree than those of the arms. The reflexes of the upper extremities are abolished in both. The scapulae are receding from the thorax in both, more in one than in the other. There is scoliosis in both. Lordosis is marked. The breathing is diaphragmatic. The pelvis and lower extremities are tilted to one side in both. Both have some difficulty in getting off a chair and in walking up stairs. They have difficulty in getting up from the floor. There is wasting of the gluteal muscles in both. Both limbs in the two patients are thin. There is some weakness of the external group of muscles of both legs, more in the son than in the father. The patellar and achilles reflexes are absent in both, even with the reinforcement method. The plantar reflex is normal in the son but frequently in extension on the left and only occasionally on the right in the father.

The atrophy is particularly evident in both legs but not in the thighs in both patients. The atrophied muscles frequently present fibrillary contractions.

The process commenced in both at an early age, in the father at 12, in the muscles of the hands; in the boy at 6, in the muscles of the legs. Three years before presentation they were both operated on for talipes equinus and for shortened achilles tendon.

The daughter, aged 15, like the other two patients, also presented difficulty in walking without aid at an early age. Three years before presentation she was operated on for double talipes valgus and for shortened achilles tendon. She also shows ankylosis at the left elbow and some wasting of the muscles below. There is no other atrophy in the upper half of the body. The reflexes of the upper extremities are absent. She shows marked scoliosis. The calf muscles and the gluteal muscles are unusually developed, and in spite of this fact she has difficulty in going up stairs. The patellar and achilles reflexes are absent on both sides. The plantar reflex is normal.

This family of three showed negative Wassermann reactions on repeated examinations. The blood chemistry and urine were normal.

The mother of the two children is normal somatically. The mental state of the three patients is normal. No other abnormality could be traced in the family of either the father or the mother. The three cases are examples of a morphologic hereditary anomaly of familial character. They belong to the category of abiotrophy. A chemical abnormality in metabolism was not detected. Evidently, certain muscular groups suffered in development and the defect of the germ plasm was transmitted from the father to the children. The tendon reflex also presents a family characteristic. The absence of these reflexes in the four extremities was not due to atrophy of the muscles, as in some of them the wasting was too slight to interfere with the response to stimulation of the tendon. In the girl, for example, the quadriceps femoris muscles are normal and powerful. The abnormality therefore lies in the central nervous system. A syphilitic basis is not present.

THE BRAIN IN A CASE OF TUMOR OF THE CEREBELLUM. DR. CHARLES W. BURR.

This case of metastatic carcinoma of the cerebellum is of interest because it is one of the rare instances of tumor of the brain presenting, temporarily, the mental (not the physical) symptoms of paresis. Mental symptoms depend more on the location than on the specific nature of the degeneration of the brain. When Dr. Burr first saw the patient (a negro, about 50 years of age), he was somewhat demented, euphoric and had grandiose delusions. Physical examination, however, showed definitely that he had tumor of the brain with cerebellar ataxia. At autopsy, the primary tumor was found to be pulmonary. The second point of interest is the importance, in cases of tumor of the brain, of determining that the disease in the brain is primary and not secondary. It would be rather useless, not to say brutal, to remove a tumor of the brain in a man who had a primary malignant growth in any other part of the body. In this case there was no question of operation.

DISCUSSION

DR. N. W. WINKELMAN: The pathology in this case is of interest for the reasons Dr. Burr has given. The patient had a primary carcinoma of the lung, which is rare. He had a cerebellar tumor which was much like a glioma; had the origin not been known, one might have been in doubt. There were also found calcified nodules, which probably had nothing to do with the case.

A TRAUMATIC CASE WITH UNUSUAL PATHOLOGIC OBSERVATIONS (SCHILDER'S DISEASE). DR. R. W. WAGGONER.

This patient was admitted to the service of Dr. Charles H. Frazier at the University Hospital, on Feb. 5, 1928, after having been struck and knocked unconscious by an automobile. The past history was essentially unimportant. A careful social service investigation revealed that up to the time of the injury there was no change in the mentality of the boy nor any evidence of loss of

hearing or vision. He had been boarded out and badly treated, and it was said that as a result of this he had become excitable and afraid. The excitability was improving under good care. He had always been considered just an average child.

Although apparently and supposedly unconscious, he frequently, either on stimulation or spontaneously, cried out with a peculiar whining type of cry. There was a slight ecchymosis under the right eye, without other evidence of cranial or spinal trauma. A small abrasion was noted over the right side of the pelvis. The blood pressure was 80 systolic and 40 diastolic. There was no evidence of facial paralysis when the patient cried. The eyes were kept closed, but there was neither strabismus nor deviation. The pupils were equal, large, round, regular and reacted slightly to light. He occasionally moved his eyes in a lateral direction. Rigidity of the neck was not present. Peristaltic movements of the intestines were absent. The abdominal muscles were soft and flat. All extremities were spastic, although at times he apparently moved the arms voluntarily. A satisfactory sensory examination could not be carried out, but he responded with cries to deep pin pricks anywhere on the body. The tendon reflexes were equal on the two sides and increased. Bilateral abortive ankle clonus and suggestive Babinski reactions were noted. He was incontinent of urine and feces. A spinal tap was done; the pressure was not increased, but the fluid was bloody. Roentgen examination of the head and spine was negative for fracture.

After about ten days he seemed to improve so that there were apparent short lucid periods, during one of which he attempted to say "good morning." No change in the condition of the extremities was noted. There were variations in temperature; at one time it was as high as 104 F. while at other times it was normal. On March 1, Dr. Fewell noted that there was conjugate deviation of the eyes to the left. The disks were beginning to look pale and the size of the arteries was reduced. On March 3, the patient obeyed simple commands such as, "Put out your tongue." It was noted that at about the time the bladder was to be emptied there was excessive sweating of the head and shoulders, which was taken to indicate pain when the bladder was distended.

During all this time, although apparently unconscious or at least unaware of his surroundings, he created much disturbance in the ward by the frequent whining cry. The cry always seemed more pronounced for a half hour or so before voiding.

At the time he was discharged, two months and two weeks after admission, the patient seemed somewhat better. He was able to say a few words and apparently was able to comprehend some things that were going on about him. The spasticity of the upper extremities seemed lessened, although that of the lower was as pronounced as on admission. The crying was much less frequent.

He was sent to the Children's Seashore Home where, after a few days he developed measles which was followed by tuberculous pneumonia which caused death on July 1, 1928.

A postmortem examination was made, but only after the body had been embalmed and two days after death. The calvarium on the right side seemed thinner than on the left. There was no evidence of fracture. The dura was adherent to the bone but not to the brain. On gross examination the brain was hard and white; signs of injury were not made out; the pia, in particular was normal as to color. A horizontal cut had been made, and so this method of cutting was continued. It was found that the white matter, bilaterally and particularly in the posterior one half, was degenerated. The degeneration stopped at the margin of the gray matter, with integrity of the arcuate fibers. The white matter, which appeared spongy and had a grayish color, seemed not unlike gelatin. The process was less marked as one approached the anterior poles. The frontal lobes, for the most part, were intact. A gross diagnosis of Schilder's disease was made.

Microscopically, the diagnosis of Schilder's disease was substantiated. There was marked degeneration of the white matter with integrity of the gray. The degeneration varied slightly from that usually found in this condition because of the marked destruction and the feeble efforts at repair, and also perhaps because

of the time intervening between death and the fixing of the specimen. The large glia cells characteristic of this condition, although present, were rather hard to find. The specimen was overrun by small round nucleated cells which closely resembled oligodendroglia cells.

This case brings up a few questions, such as: Did the disease begin after the boy was struck by the automobile or was he hit because of the beginning blindness and deafness caused by his condition? Was the marked degeneration noted partly post mortem or did the injury markedly increase the progress of the disease? It is also interesting to note, in retrospect, that the child's frequent cry was not unlike that described as being typical of Schilder's disease, although it became less marked and less frequent as the general condition improved.

DISCUSSION

DR. N. W. WINKELMAN: The first case of Schilder's disease I saw was in 1920. This case is the second. I was surprised to find a history of injury. I asked Dr. Frazier, was the boy unable to avoid the accident because of oncoming blindness and deafness? I am surprised that the symptoms were not noticed.

DR. W. G. SPILLER: Were any symptoms present before the child was struck?

DR. R. W. WAGGONER: The situation in the family was odd. The father and mother are divorced; the mother works and the child had boarded out, but was later kept by people with whom the mother was stopping. These people declared definitely that there was neither mental change in the child nor evidence of oncoming blindness or deafness.

DR. W. G. SPILLER: There is the question whether their statements can be accepted. They might have overlooked the degrees of changes. I am surprised to hear you say four or five days.

DR. R. W. WAGGONER: One or two cases have been reported in which the course of the disease, from the time of the examination or onset of symptoms until the death of the patient, was four or five days.

DR. W. G. SPILLER: It sounds to me as though there were two different conditions. He may have had Schilder's disease and traumatic symptoms. I think there were two different processes. The trauma probably increased the symptoms seen later.

DR. R. W. WAGGONER: Because of that possibility we made this investigation and were unable to find any evidence of symptoms before the accident. We did not examine him until after the accident had occurred.

Book Reviews

Die epidemische Encephalitis. By Prof. Dr. Med. Felix Stern, Nervenarzt in Kassel, Ehem. Oberarzt der Universitäts-nervenklinik Göttingen. Second edition. Price, 56 R. M. Pp. 541, with 71 illustrations. Berlin: Julius Springer, 1928.

One need only possess this volume to have at hand literature of practically the entire world, arranged in such manner as to be easily accessible. Since the first edition of this book, an enormous amount of work has been done on epidemic encephalitis, so that this second edition was necessary.

The first division deals with the clinical side, taking up the symptoms of the acute stage; each individual symptom is discussed separately and references are given to the literature: (1) changes in consciousness; (2) paralysis of the eye muscles; (3) paralyses of other cranial nerves; (4) disturbances of muscle tone and muscle power; (5) hyperkinetic symptoms; (6) frequent neurologic accompanying symptoms; (7) infrequent symptoms; (8) "scar symptoms" (Narbenerscheinungen) after the acute symptoms. Under the last division are considered particularly the effects on the glands of internal secretion, with especial emphasis on dystrophia adiposogenitalis and diabetes insipidus. The second division takes up the neurologic symptoms of the chronic stage under the following heads: (1) akinetic hypertonic symptom-complex, with and without tremor; (2) the hyperkineses; (3) the vegetative accompanying signs, including sialorrhea, hyperhidrosis, dacryorrhea, etc.

The third division considers the psychic manifestations of epidemic encephalitis: (1) the psychic disturbances of the acute stage; (2) the psychic changes of the pseudoneurotic stage; (3) character changes; (4) the psychic accompaniments of the akinetic-hypertonic stage; (5) the hyperkinetic psychomotor changes and schizophrenia-like manifestations in chronic encephalitis; (6) paroxysmal disturbances. The fourth division discusses the changes in the spinal fluid, taking up separately the changes in the acute and those in the chronic stages. The fifth division includes the general changes of the whole organism. The sixth division discusses the prognosis.

An entire chapter is devoted to a discussion of the story of the epidemic and its progress. The pathologic anatomy is reviewed in twenty-five pages, mainly from the author's own work. He does not, however, omit reference to the work of others. The acute and chronic stages are described individually, as regards not only the nervous system but also the changes that occur in other organs. The etiology and pathogenesis come in for due discussion, and here the work of American authors is impartially discussed.

The relation of epidemic encephalitis to other diseases is given separate consideration, and a chapter is devoted to diagnosis and differential diagnosis, one to social and forensic relations and, finally, one to treatment. The literature is given in detail.

Little comment is necessary. This monograph is certainly the outstanding work on the subject of encephalitis; every one interested in the subject should read it. Unlike some other German publications, this book gives consideration to foreign literature as well as to the German. Professor Stern is to be congratulated on this monumental work.

Encephalitis Epidemica med Optikusforandringer. By Knud Winther. Pp. 278. Copenhagen: Levín & Munksgaard, 1927.

It is deplorable that the author did not follow the example of his distinguished countryman, August Wimmer, who wrote his excellent monograph on chronic epidemic encephalitis in English. Fortunately, the main facts stated in Winther's monograph are given in an article written in French (*Acta psychiat. et neurol.* **3**:165, 1928). He finds that involvement of the optic nerve is more frequent than is generally supposed, as he has collected 150 cases from the literature and has

observed thirty-two cases personally. Eight of these cases were verified by necropsy. Naturally, a wrong diagnosis of brain tumor frequently has been made, leading to exploratory operations. Papilledema in encephalitis is prone to appear suddenly and to disappear spontaneously or after repeated lumbar puncture. It sometimes leads to blindness. Most frequently the cause is increased intracranial pressure. In a very few cases it is due to local mechanical conditions such as chronic meningitis about the optic nerves or chiasma, in which case it may be largely unilateral. All grades of optic neuritis may occur, from a transient form without prominence of the disk or reduction of vision to fulminant retrobulbar neuritis with acute blindness. Particularly important is the combination of retrobulbar neuritis and marked papilledema which not uncommonly gives rise to an erroneous diagnosis of brain tumor. The presence of central scotoma during the period of failure of vision speaks in favor of this type of disease. Sometimes there has been papilledema in one eye and optic neuritis in the other. The optic nerve changes have been observed in both the acute and the chronic changes of the disease. The manometer often has revealed cerebrospinal fluid pressure as high as 600 mm. of water. There are often associated certain cerebral symptoms which also are rare in epidemic encephalitis, such as aphasia, hemiplegia, hemianesthesia and hemianopia. In all of Winther's eight cases studied histologically, there were lesions of the cortex. The presence of symptoms on the part of widely scattered portions of the central nervous system is of diagnostic importance as favoring encephalitis against brain tumor. As many of these cases resemble the so-called serous meningitis, the author has closely investigated the relationship between this disease and encephalitis. Many cases described as "pseudotumor cerebri" have probably been cases of chronic encephalitis. Encephalographic studies indicate that while the papilledema and increased intracranial pressure often are due to internal hydrocephalus, in other cases they appear to be due to diffuse swelling of the brain and meninges, possibly edema.

The treatment of the optic nerve complication must be guided largely by the condition of the vision. If much visual impairment and signs of atrophy are present decompressive operation or ventricular puncture is indicated. If vision is good and no signs of atrophy are present, repeated lumbar punctures may be used provided the patient can be kept under observation. Lumbar encephalography is helpful in the exact determination of the conditions present, as it may demonstrate the existence of relatively closed internal hydrocephalus or other abnormalities.

THE TRUTH ABOUT MIND CURE. By WILLIAM S. SADLER, M.D. Price, $2. Pp. 206. Chicago: A. C. McClurg & Company, 1928.

This small book, the work of a surgeon, is written with a finality which does not permit of any compromise or difference of opinion. The author implies in the title that the last word on the subject has now been said, rendering further discussion unnecessary.

It is announced in the preface that the book commemorates the one thousandth delivery of the author's lecture on "Faith and Fear," "To audiences from Maine to California and from the Canadian Border to the Gulf." It is peculiarly dogmatic throughout and abounds in platitudes and unverified statements, which removes any slight claim it might have otherwise to scientific value, although two pages from the end of the book, the writer expresses his conviction that "I have told the truth about mind cure and all that I have written up to now is scientific truth." In partial justification of the style of the book, it should be said that it is intended for the layman. Even so, there is no excuse for a presentation which does not take any account of the actual progress of psychotherapy and the deeper knowledge which recent psychologic research has brought into a study of the psychoneuroses. Just what such a superficial discussion may accomplish for good or ill is problematic, but some satisfaction may be derived from the fact that a surgeon has stated that psychotherapy has come to demand a place in the sun. The book contains much that is true and generally accepted, but more that is entirely out of touch with the best recent thought on what is to most people an involved and controversial subject.

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